

digit **FastTrack**

YOUR HANDY GUIDE TO EVERYDAY TECHNOLOGY

TO **3DS MAX**

- ▶ User interface
- ▶ Modelling
 - ▶ Character Anatomy
 - ▶ Textures
 - ▶ Lighting
 - ▶ Rendering
 - ▶ Rigging
 - ▶ Animation
 - ▶ Special Effects



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Fast Track

to

3ds Max



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Introduction

Autodesk 3ds Max is a very powerful software with integrated 3D modelling, animation, rendering, and compositing tools that enable visual graphic artists and CG designers an effective and faster solution to bring 3D graphics into production.

Graphic design and 3D modelling is more of an art and requires a creative aptitude rather than strict theoretical knowledge. But with the advent of very fast processing capabilities and advances in motion graphics, it becomes empirical to be abreast with the latest software in 3D and how to use them. The applications and scope of 3D design is plenty. People these days are either programmers or artists and there are very few people who are both.

With the introduction of software such as 3ds Max, this gap could be bridged. 3ds Max is the perfect package for people who are stuck between the two choices. 3ds Max can be as technical as you would ever want, yet it still allows an artist to easily create stunningly beautiful images. For the artist, learning something as technical as 3ds Max can seem daunting, and for technical people, creating a beautiful image can be challenging. This Fast Track aims to get you up to speed with the most primary uses of 3ds Max so that you can experiment yourself and follow along on the path you want.

This edition is certainly not an authoritative book on 3ds Max and obviously does not explain everything there is to explain in the vast world of 3d modeling. The software in itself is so robust and complicated; it would take a lot more to dwell into the details of the working of the software. We just try to cover the basics of modeling, texturing, lighting, rendering and special effects. Any further areas like building games and integrating CG graphics into video is beyond the scope of this edition. But none the less, this Fast Track is an attempt to give you a basic understanding and arm you with the right tools to take it further. 

1 User interface

3ds Max is an extremely useful software tool for all major types of 3D modelling, animation, special effects, and graphics rendering in the areas of graphics intensive video gaming, special effects and CGI in feature films. 3ds Max is a power house of features that can help you with most graphics projects and generate incredibly realistic or highly stylised three dimensional graphics. But then again, the humongous number of features and options available in 3ds Max might seem very daunting for most newcomers. But because of this very same problem, the software is built very consistently and the interface is made as intuitive as possible. Once you start trying out new things and experimenting with the interface, you can keep moving into new areas and get a hang of things. Only then will you be able to experience the real power of 3D in Max.

1.1 The interface: your playground

The first step in getting familiar and working with 3ds Max is getting a hang of the interface, the different menus available and how to make proper use of them. If you're trying your hand at 3ds Max for the first time, you should spend some time viewing the videos in the 'New Features and Essential Skills Movies' section. You'll find this in the menu while the program is launched, and will give you a basic idea of the software. Once you've gone familiar with the menu, simply uncheck the 'Show this Dialog at startup' option at the bottom left of the window.

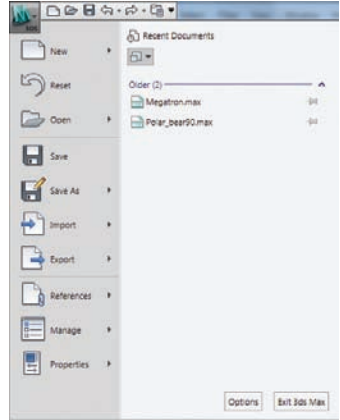
Most of the components in the 3ds Max interface are similar to the ones you'll commonly find in Windows. On the other hand, there are a few counter intuitive components that are specific to 3ds Max. Therefore it is good to first get a proper understanding of how things are organised. 3ds Max has a plethora of tools and options; in fact, there are so many of them that it'd get overwhelming.



The New Features and Essential Skills Movies Dialogue Box

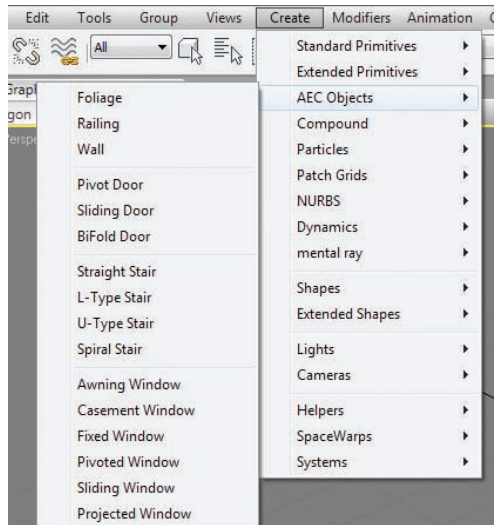
1.1.1 The Menu Bar

This is where you will find typical options you'll frequently access. It's located on the top of the window, similar to other Windows programs. Also since the 2010 edition, you will find an Application button which is the graphical representation of the different types of tools in the traditional File menu drop down. The Application button is also where you can set a project folder, access the Asset Tracking tool, and check statistics about the current file. In case you still want to use the traditional File menu, you can restore it to the 3ds Max interface from the Customize User Interface dialog box, under Customize.



The Application Button and Menu (Button at the top left corner of the screen)

Clicking a button in the menu bar issues a particular command and Max will take the required action. An option that's followed by three periods, called an ellipsis, opens a dialog box, which allows you to edit settings related to that particular option. An icon which has an arrow pointing to the right shows more options. This is called a cascading menu.



A Normal Cascading menu

1.1.2 The default Startup Layout

3ds Max can be very tricky at times. Because of the wealth of options available

and if it changes its appearance getting work done can be a very tedious job figuring out what's where. Even between two different 3ds Max versions such as 2010 and 2010 design, there are major differences in the interface design. In 3ds Max 2010 you will see an interface, with the tools attune with the game and entertainment type of projects. If you find your 3ds Max User

Interface doesn't seem familiar, select 'Revert to Startup Layout' from the Customize menu. You can save and load custom interface schemes you setup for use according to your convenience.

1.1.3 The Quick Access Toolbar

To the immediate right of the application menu is the Quick Access toolbar, which is a new addition to all versions of 3ds max since 2010. As the name suggests, the toolbar provides control over a number of useful features such as New Scene, Open File, Save File, and the Select Project Folder Browser. In case of the newer versions, the Undo Scene Operation and the Redo Scene Operation tools have also been added to the Quick Access Toolbar. You can use these buttons to undo your previous actions, up to 25 times by default, and redo undone actions. The drop down menu beside the Undo or Redo buttons shows you a list of actions available for you to select. You can also customize the Quick Access toolbar according to your preferences at the right end of the toolbar.

Consider Dual-Screen System

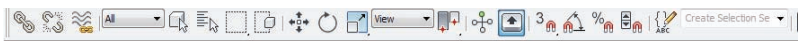
In 3ds Max, and with most other graphics programs, no matter how big your screen might be it's never enough. You can always use a two monitor system to help you improve the speed of your workflow and unclutter your screen. You can just move out your items such as floating toolbars, the Material Editor, Curve Editor, Rendered Frame Window, and so on onto the second monitor, in effect making more room for you to work on your project in the viewports.

1.1.4 The Information Center Toolbar

If you notice the top right corner of the screen, near the place where Windows programs conventionally have the Close, Minimize and Maximize buttons, you will find the Information Center toolbar. This toolbar gives you a search function for the different 3ds Max topics present in the local Help files and also on the Autodesk web site called the Subscription Center. The Communication Center is the place where you will get notices for the new software updates and other major announcements.

1.1.5 The Main Toolbar

Immediately under the menu bar you will find the main toolbar. The tools available in this toolbar have tooltips to explain what they do better. These tooltips become visible to you when you hover your mouse cursor over these icons. The first section of tools on this toolbar is for linking and selecting objects. There are two Linking tools, a linking and an unlinking tool. Linking and unlinking in 3D



The MainToolbar

Modelling is necessary because an object needs to move, rotate, or scale, based on the restrictions and properties assigned to another object. The third Linking tool in the section is the Bind to Space Warp tool. It is used to attach objects and space warps together. Then comes the selection tools that let you select objects by clicking on them or by selecting them by name. The Selection filter lets you to limit what can be selected with the cursor. You can also choose to specify the method for selecting objects by using a selection window, which lets you indicate a selection by placing a rectangle, circle, or other border around the objects.

To the right of the Selection tools are the Transform tools. This set of tools lets you move, rotate, and scale objects. You can also choose the reference coordinate system, set the centre of the transform using the pivot options, toggle keyboard shortcut overrides, use different snap options, work with named selection sets, and use tools to mirror and align objects. The next group of tools to the right includes access to the Layer Manager, Graphite Modeling tools, the Track View Curve Editor, Schematic View tools, and the Materials and Rendering tools.

The Layer Manager gives you control over all the settings for layers in your scene and the objects contained in those layers. The Graphite Modeling tools are a completely new set of over 100 tools to improve creating and editing poly objects within 3ds Max. The Curve Editor tools display your scene information as graphs or wiring diagrams to indicate the functionality or relationships of scene objects. The Schematic View tools provide a visual graph and control how all the elements of your scene are linked. The Materials tools give you control over the appearance of objects by defining and applying their surface properties. With these tools, you can create color, texture, opacity, and other material characteristics, and then apply these characteristics to objects in your model. You can also open the Render Setup dialog box, select the render type, and perform a quick render with the buttons on the far right.

The Rendering tools give you control over the image output of your 3ds Max scene. Unlike output from most applications, output from 3ds Max Design 2010 is most likely to be image or animation files, or real-time virtual models. The Rendering tools let you set the type and size of output, from single, large-format stills to video-ready animations.

1.1.6 Working on a Lower-Resolution System

In case you are working on a screen with a screen resolution less than 1280x1024, you probably will not be able to see all the different tools in the main toolbar. Some of the tools just become unavailable after the right end of

the screen. To be able to access these particular tools, you can place the cursor on the toolbar and wait till the Hand icon appears. Then it's merely a matter of clicking and dragging the toolbar to the left. In case you are unable to replicate this exactly as explained, just move your cursor under one of the dropdown lists in the main toolbar to access the Pan Hand. You should know that the smallest supported screen resolution for the UI in 3ds Max Design 2010 is 1024 x 768, but the recommended resolution is 1280 x 1024 or higher.

1.1.7 Docked and Floating Toolbars

Apart from the main toolbar, you also have several other floating toolbars that may or may not be visible above the viewport. Many of the toolbars are hidden by default. You can find and gain access to any such hidden by right-clicking on a blank space of an open toolbar and selecting the hidden toolbar from the context menu that appears.

All the toolbars apart from the ones already discussed tend to float over the viewports. Few of the major toolbars which do this are the Layers, Render Shortcuts, Snaps, Axis Constraints, and the Extras toolbars. But just like the other toolbars, you can dock these floating toolbars to any side of the UI or just hide them for better visibility of the viewports. You can resize them by clicking and dragging any of their edges.



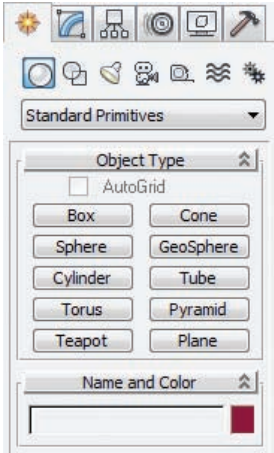
The Flyout options for the Scale Button

1.1.8 Toolbar Flyouts

You should have already noticed that some of the tools in the main toolbar have a small arrow in the bottom right corner of the tool's icon. This particular arrow indicates that the tool is one of several offered in a flyout.

1.2 The Command Panel

For most of your basic work in 3ds Max, the Command panel is what you will be using the most. The Command Panel is a single entry point for most functions. The Command panel offers nearly all the tools for creating and editing in 3ds Max. Across the top of the Command panel, you'll see a set of six tabs, each displaying an icon. From left to right, the tabs are Create, Modify, Hierarchy, Motion, Display, and Utilities. If you place the cursor on a tab, you'll see a tooltip displaying the name of the tab. When you click a tab, the functions relating to the tab appear in the rest of the Command panel. Here's a brief rundown of what each tab offers:



The Command Panel (on the extreme right of the screen)

Create - Contains tools for creating objects such as geometry, cameras, lights, and more

Modify - Contains modifiers that can be applied to objects to control a myriad of tasks such as modelling, animation, texturing, and more.

Hierarchy - Contains tools for managing links in a hierarchy, joints, and inverse kinematics.

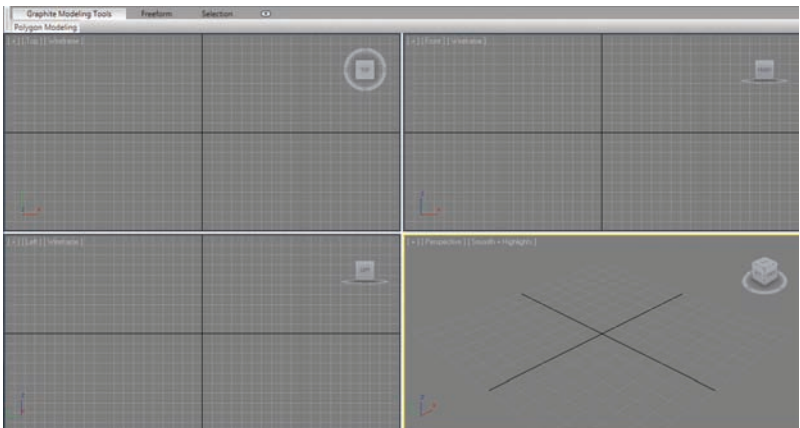
Display - Contains tools that modify the way objects are displayed, along with tools to hide, unhide, and freeze objects.

Utilities - Contains miscellaneous utility programs and plug-ins to help manage the scene and objects within the scene.

Motion - Contains tools for creating and modifying animation and trajectories as well as applying animation controllers.

1.3 The Viewports

There are viewports at the centre of the 3ds Max workspace. All of your major modelling work is done here. When you open a new 3ds max file or project, the viewports show a grid that you will use as a reference for orientation and size. At the lower left corner of the viewport, you should be able to find the World Axis Tripod that indicates the orientation of the X-, Y-, and Z-axes. The World



Four different viewports – Top, Front, Perspective and left (in clockwise order)

Axis Tripod also helps you get your bearings when you are looking at camera and perspective views. By default, there are four viewports named Top, Left, Front, and Perspective, as indicated by the labels in the upper left corners of each viewport. You can also tell that the Perspective viewport is different from the others by the way the grid squares get smaller and converge in the distance. You can configure and view your model in a variety of ways, depending on your needs using the different viewport settings.

1.3.1 Shading

Each viewport can have a different type of shading set associated with it. Similarly, you can have a different view in each viewport. This is very helpful since you can see different sections of a particular scene in different styles. While modelling, you may choose the wireframe mode. Similarly, while rendering, you can choose any of the shaded modes. The quality of shading depicted depends on your computer's graphics card as well as the graphics mode. For example, Direct3D drivers are much faster and will show more realistic textures and transparencies, whereas OpenGL drivers are faster for deforming meshes, used in character animation.

The Wireframe mode shows a basic outline of the object; Smooth, the object rendered; and Wireframe On Shaded, the wireframe superimposed on a shaded object. The Facets mode shows the model without smoothing, with polygonal edges visible. Flat eliminates shading for a more 2D look. Bounding Box creates a box around the object. Bounding Box is great for navigating complex scenes that update slowly in rather detailed modes.

1.3.2 Navigation

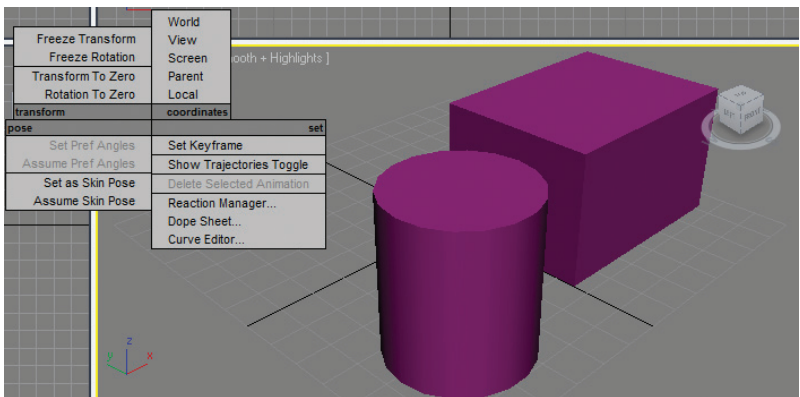
You can navigate using a mouse, or by the navigation bar at the bottom-right corner of the screen. Mouse navigation is accomplished by using the middle button along with the keyboard. The navigation bar at the bottom-right corner of the screen contains additional navigation tools. Middle-click and drag, to pan the viewport. Rolling the middle button zooms into the object. If the mouse does not have a rolling middle button, press [Ctrl]+[Alt] while pressing the middle button to zoom. Hold down the [Ctrl] key while pressing the middle button to rotate around the scene.

1.3.3 Selecting Objects

3ds Max has a wide range of object types that includes geometry, lights, cameras, and bones. You can select objects individually, by group, and by name. Objects can be selected individually or in groups by using the mouse.

While left clicking an object selects it, left clicking and dragging selects a region. Hold the [Ctrl] key while selecting your additions to a particular selection. By holding down the [Alt] key, you can remove elements from the selection. You can name grouped objects, to be selected later. This is done by using the Selection Sets pull down menu on the main toolbar. To create a set, simply type the name of the set and press [Enter]. This places the set in the pull-down menu, where it can be recalled later. Sets can be edited by left-clicking the icon to the left of the pull-down.

1.3.4 Quadmenus



The Quad menus

Quadmenus are a set of context sensitive menus that are activated when you right-click on any viewport. There are four menus that contain the most commonly used commands for the particular situation. If you're modelling, you'll see modeling commands. In a quad menu, Display and Transform tools are in the right quadrants, while context sensitive tools are on the left.

1.4 Transforming Objects

Selected objects can be moved, rotated, and scaled. These transforms can be accessed by using the icons on the main toolbar or by pressing the hot keys [W] (Move), [E] (Rotate), and [R] (Scale). Each transform uses a colour-coded gizmo. Red transforms along the X-axis, green along the Y-axis, and blue along the Z-axis. Clicking and dragging in the centre of the gizmo transforms the object on all available axes, while clicking in the box connecting two axes transforms on only those two axes.

1.4.1 Coordinate Systems

Transformations can take place along a number of user selectable XYZ coordinate systems. These change how the transform gizmo is oriented relative to the object. 3ds Max has several types of coordinate systems, including View, Screen, World, and Parent.

1.4.2 Pivots

A pivot is located at the centre of each object's coordinate system, which is particularly important when rotating an object, because the object will rotate around the pivot. Pivots are managed in the Command panel under the Pivot panel of the Hierarchy tab. When the pivot is placed outside the wheel, the wheel rotates around its edge. When the pivot is in the centre of the wheel, it rotates around the axle.

Pivot panel – This panel contains tools to adjust an object's pivot.

Affect Pivot Only – Allows you to move the position of the pivot.

Affect Object Only – Allows you to move the object while the pivot remains stationary.

Affect Hierarchy Only – Applies the rotation or scale to the hierarchy by rotating or scaling the position of the pivot point without rotating or scaling the pivot point itself.

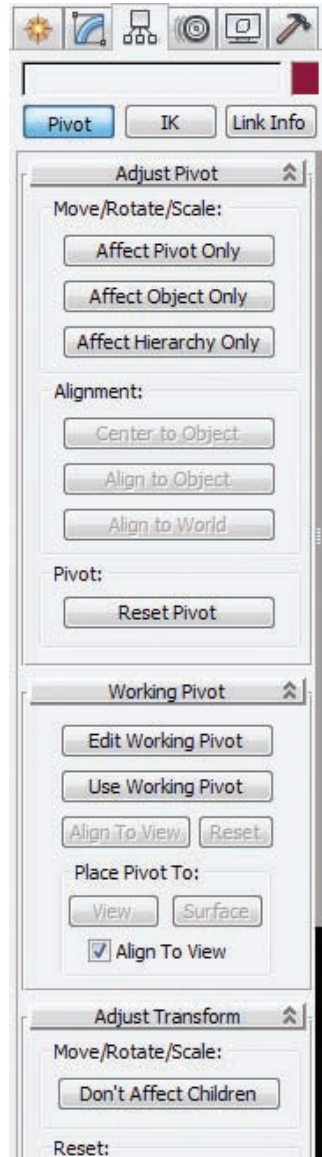
Center To Object – Moves the pivot to the center of its object.

Align To Object – Rotates the pivot to align with the object's transformation axis.

Align To World – Rotates the pivot to align with the world axis.

Hierarchy tab – The Pivot panel is located under the Hierarchy tab.

Reset Pivot – Resets the pivot to when the object was first created.



The Pivot menu under the Hierarchy Tab in the Command Panel

Don't Affect Children – Moves the pivot without affecting the position of child objects in the hierarchy.

Reset Transform – Resets the transform to zero.

Reset Scale – Resets the scale of the object to 100 percent.

1.4.3 Snapping

The Object Snapping tools are good for snapping objects to precise positions. When you are moving objects, these tools let you snap objects to grids, other objects, or parts of other objects. Rotations can be snapped so the object rotates in specific increments.

Vertex – Snaps to a polygonal, mesh, or patch vertex

Pivot – Snaps to the pivot point of an object

Grid Points – Snaps to grid intersections

Endpoint – Snaps to the end points of edges on meshes or spline vertices

Midpoint – Snaps to the middle of edges on meshes and spline segments

Edge/Segment – Snaps to a polygonal or mesh edge or a spline segment

Face – Snaps anywhere on the surface of a face

Frozen – Snaps to frozen objects

Axis Constraints – Brings up the axis constraints toolbar, which limits motion along specified axes

1.5 Managing Objects

3ds Max has a number of tools that allow you to manage the display and behaviour of objects within the scene. Objects can be organized by type, colour, and name. Objects can also be hidden or frozen. This helps to organize scenes and eliminate clutter.

1.5.1 Hiding and Freezing Objects

3ds Max has the capability to hide objects from view, or to freeze them so that they can be viewed but not selected. If you're working with one set of objects, for example, you can hide or freeze other objects in the scene to make it easier to select and manipulate the desired objects. Selected objects can be hidden and/or frozen by using the quad menu or the Display panel.

1.5.2 Using Layers

Another way to manage objects is to separate them into layers by using the Layer Manager, which is accessed through the main toolbar. A layer is simply a collection of objects. Each layer has a unique name, and layers can be hidden or frozen. Layers can also be used for such tasks as rendering.

1.5.3 Using Groups

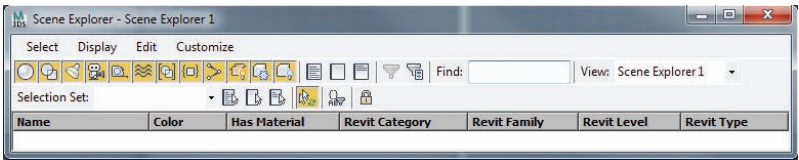
3ds Max can also combine objects into groups by using the Group menu on the main menu. Once grouped, objects appear as a single object in your scene. You can click any object in the group to select the group object, and then transform or modify it however you choose. Groups can be nested, so you can group objects, and then group again with another set of groups or objects.

1.5.4 Linking Objects into Hierarchies

3ds Max can connect objects together in a hierarchy in a way that one object can parent other objects. Moving the parent object also moves the children. Hierarchies are very useful in animation because they can attach objects to one another, so when one object moves, the rest follow. Linking is done by using the Select and Link tool on the main toolbar. Select the object or objects to be linked, and drag the link to the desired parent.

1.6 Scene Explorer

Scene Explorer is a new feature from 3ds Max 2008 onwards. It presents a comprehensive view of all the objects in a scene. Objects can be sorted, filtered, and selected from within Scene Explorer. Changes can also be made to individual objects or groups of objects. Scene Explorer is very helpful for large scenes with many objects. Scene Explorer allows you to create custom views for different types of objects, so you could have a view to display just lights and lighting parameters.



The Scene Explorer Window

Scene Explorer can be used to select objects as well as change their parameters. Object can be selected by clicking, by using selection sets, or by using the Find utility. Selected objects appear in the 3ds Max scene. You can also change parameters for selected objects by adjusting the parameters listed in the columns. The Find utility allows you to search the scene for objects that meet specific criteria. Clicking over a column for selected objects allows you to change the parameters for those objects. In this case, the colour of the highlighted objects is being changed. **d**

2 Modelling

In the world of computer graphics, the objects in your scene are called models, and represent the objects in your scene. They can range from objects composing a set, to the characters that populate the set. Modelling is similar to sculpting in a sense: as is the case with a good sculptor, a good modeller too, needs to have a good sense of form and volume. While a sculptor works with stone, clay or some other materials, a modeller works virtually, with wireframes and geometry. 3ds Max provides a wealth of tools to shape and sculpt geometry into the shape you desire.

2.1 Understanding geometry types

3ds Max has several ways to represent geometry: meshes, polys, patches, and NURBS. Each type of geometry has its own way of representing a model, and each has its own benefits. Objects can be converted from one type to another, but ultimately, each type of model resolves to triangular polygons when the model is rendered.

2.1.1 Editable mesh

An Editable Mesh is a polygon based object that uses triangular polygons. Editable meshes are useful for creating simple, low-polygonal objects or control meshes for subdivision surfaces. You can convert a NURBS or patch surface to an editable mesh. Editable meshes require little memory and are a natural method of modelling with polygonal objects.

2.1.2 Editable poly

An Editable Poly is a type of deformable object. An editable poly is a polygonal mesh; that is, unlike an editable mesh, it can use more than three-sided polygons. Editable polys are useful in that they avoid invisible edges and have a more-robust set of editing tools. You can convert NURBS surfaces, editable meshes, splines, primitives, and patch surfaces to editable polys.

2.1.3 Editable patch

Editable Patch objects are useful for creating smooth surfaces, and provide very detailed controls for manipulating complex geometry. Unlike a polygonal object, a patch has curvature controls on each vertex to adjust the curvature of the surface.

2.1.4 NURBS

NURBS modelling is exceptionally good at creating smooth, splined surfaces by using a minimum of points. NURBS is an acronym for non-uniform rational B-spline, the type of spline that defines a NURBS surface.

2.2 Creating Geometry

Geometry in 3ds Max is created by using either the Create menu on the main menu or the Geometry tab of the Create panel. This tab has a pull-down menu from which you can select different categories of objects to create. Most objects created are known as parametric objects. In other words, they use parameters to define the shape and form of the object. Only when an object is edited by using a modifier or modelling tool does it actually become a specific type of geometry.

2.3 Basic Primitives

The basic primitives are basic shapes, such as spheres, boxes, and cylinders. Each shape has its own controls to define the size of the object and amount of detail, as well as other parameters unique to the type of object.

Box: A box with definable detail. It is created by clicking on a viewport and dragging to define the base, and then dragging again to define the height.

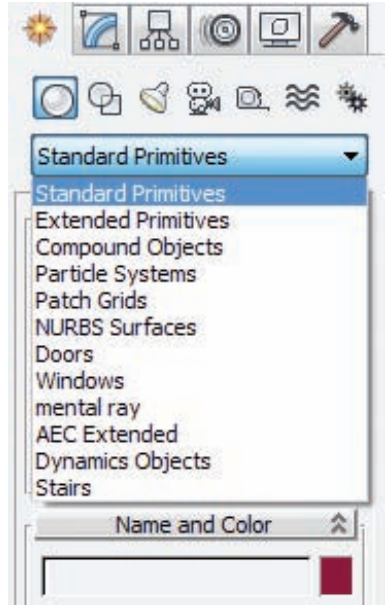
Sphere: A sphere shape with the geometry represented as latitudinal and longitudinal lines. A sphere is created by clicking in a viewport and dragging to the desired size.

Teapot: This object is the standard Utah teapot. Click and drag to set the size.

Cone: A cone is created by clicking on a viewport and dragging to define the base, and then dragging again to define the height.

Cylinder: A cylinder is created by clicking on a viewport and dragging to define the base, and then dragging again to define the height.

Torus: A doughnut shape. Created by clicking on the viewport to define the



The pull down menu of the Geometry tab in the Create Panel

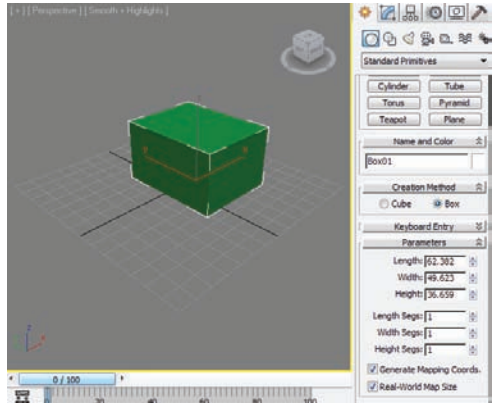
first radius and then dragging again for the second radius.

GeoSphere: A spherical shape with the detail oriented in a geodesic pattern. This creates a smoother edge with less detail.

Tube: A tube shape. Created by clicking and dragging to create the outer diameter, dragging again to create the inner diameter, and dragging a third time to define the length.

Pyramid: A four sided pyramid. Created by clicking on a viewport and dragging to define the base, and then dragging again to define the height.

Plane: A flat plane. Created by clicking on a viewport and dragging to define the outer edges.



The Parameters windows for a box

2.4 Extended Primitives

Extended primitives are of more-complex shapes. Sometimes these shapes will be closer to the form you need and can make good starting points for further modelling.

Hedra: A polyhedral shape. Can be a tetrahedron, octahedron, dodecahedron, as well as a star shape.

Chamfer box: A box with user-definable chamfers to round off the edges.

Oil tank: A cylindrical shape with hemispherical caps on the ends.

Spindle: A cylindrical shape with cone-shaped caps on the ends.

Gengon: A cylindrical shape with user-defined fillets between the major sections.

RingWave: An object used in special effects to simulate shock waves.

Prism: A triangular prism.

Torus knot: A shape with a complex knotted structure.

Chamfer cylinder: A cylinder with user-definable chamfers to round off the edges.

Capsule: A cylindrical shape with spherical end caps.

Hose: A user definable expandable hose shape

L-Ext: An extruded object that resembles an L shape. Useful for creating walls.

C-Ext: An extruded object that resembles a C or a U shape.

2.5 Architectural Primitives

3ds Max has a wealth of architectural primitives. These can be anything from doors and windows to staircases to foliage. Mostly these are used by architects, but they can also be used in animation for sets and backgrounds.

2.6 Using Modifiers

Once you've created your geometry, you can shape it further by using Modifiers. You'll find this under the Modifiers menu or in the Modifier List pull-down of the Modify panel. Modifiers can be used either on the entire object, or be restricted to parts of the object. They can also be combined by using the modifier stack to create more-complex shapes.

Parametric Deformers

Parametric deformers rely on user-defined parameters to change the shape of an object. This means you can change their values after they're applied and also animate them. Here are a few of the more commonly used deformers:

Bend: Bends the geometry around a user-definable axis

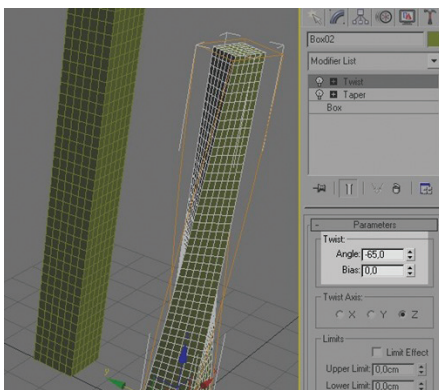
Taper: Tapers an object with a user-definable curvature

Twist: Applies a screw-like twist to the object

Skew: Skews the object in a user-defined direction

Relax: Softens the hard edges of an object

Spherify: Deforms the object to a spherical shape



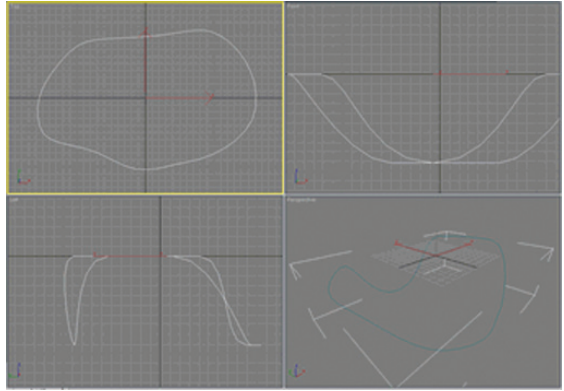
The twist deformer

Adjusting Modifiers

Modifiers can be stacked in the Modify panel to create complex effects. Changes to one modifier will flow through the stack, giving you a wide degree of control over the modifications to an object. Modifiers can be rearranged simply by clicking and dragging. You can collapse all or part of the modifier stack. This locks in the changes and makes for a simpler object. Having a lot of modifiers on an object can take up a lot of system overhead, so collapsing the stack when an object is finished will make the scene update more quickly.

2.7 Using Splines

In 3ds Max, a spline is a Bezier-based line that defines a closed or open shape. Splines are typically used as building blocks to create other objects within 3ds Max, but they can also be rendered to create cylindrically shaped



Splines

objects. Splines can also be used as animation paths or to control inverse kinematic (IK) chains. Splines are created by using the Shapes tab of the Create panel. You can draw free-form lines or create a number of predefined shapes, such as circles, rectangles, helixes, and text.

Drawing Lines

The Line object under the Create panel will allow you to draw a line in a viewport. Lines are drawn by clicking in the viewport to lay down the vertices. Clicking the viewport creates the type of vertex defined under Initial Type, while clicking and dragging creates the type of vertex defined under Drag Type. This allows you to shape the line as it is drawn, reducing the amount of editing.

Editing Splines

Splines created by using the Line object have editing tools built in. Splines created by using any of the parametric tools such as Circle, Helix, or Text can be edited by applying an Edit Spline modifier to the stack. Splines have three classes of sub-objects: vertex, segment, and spline. Vertices are the points that define the line, segments are the portion of the spline between two vertices, and a spline is the entire line. A Spline object is not limited to a single line. A vertex on a spline can be one of four types a Corner, a Bezier corner, a Bezier and a Smooth. Besides manipulating the geometry itself, detail can be added to splines, and splines can be connected by using the tools located under the Geometry tab.

Attach: Attaches another spline object to the current spline

Weld: Welds two end points together to connect two splines as one

Insert: Inserts a new vertex by clicking on a spline

Connect: Connects two end points together by using a segment

Fillet: Creates a rounded corner on a spline

Chamfer: Creates an angular corner on a spline

Outline: Creates an outline for the selected spline

Rendering Splines: Any spline can be rendered, either in the viewport, renderer, or both. Splines are rendered as cylindrical shapes, and rendered splines can be an easy way to model all types of objects.

Creating Geometry with Splines: The most common use of splines is as building blocks for other types of geometry. Because splines are curved shapes, they're excellent for creating smooth, organic surfaces. 3ds Max provides a number of tools to create objects by using splines.

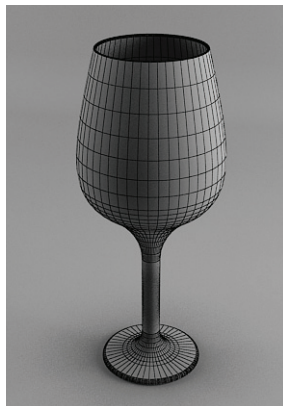
Lathe: The Lathe modifier revolves the spline around a user-defined axis to create a surface.

Extrude: The Extrude modifier adds depth to a spline. It can be configured with caps on or off.

Sweep: Sweep uses the spline as a path to sweep a user-defined shape, which can be selected from a pull-down list.

Loft: Found under the Geometry/Compound Objects tab, Loft takes two separate splines and uses one for an extrusion, the other for the path. The shape can be further modified by using a deformation graph found under the Deformations rollout.

Surface: The Surface modifier takes a "cage" made of splines and uses it as the basis to create a smooth surface. The cage is constructed by drawing multiple splines and snapping their vertices together at the intersection points.



The lathe modifier for surfaces that can be formed by revolving the spline around an axis

2.8 Polygonal modelling

Polygonal modelling is the most common form of modelling used in 3ds Max and is one of the more-intuitive ways to model. Polygonal models are easy to construct and have no topology limitations.

The downside to polygonal surfaces is that they are not resolution independent. Low-resolution polygonal models tend to animate quickly and are used extensively in games, but their lack of detail makes them undesirable for high-resolution rendering, such as for film or video. To overcome this limitation, 3ds Max has several subdivision surface modifiers

that allow a low-res model to be smoothed automatically at render time so that artists can get the best of both worlds.

Polygonal components

Polygonal surfaces have four major components: vertices, edges, faces, and elements. Editable mesh objects also have a triangular face sub-object, while editable poly objects have a border sub-object. To select one of these components, highlight an icon in the Selection rollout; select the sub-object in the modifier stack, or right-click over the surface to open a quad menu, where the sub-object can be selected. The types of polygonal components are:

- A vertex represents a single point in space; vertices are the building blocks of all polygonal objects.
- An edge connects two vertices, forming a line. Edges also connect the sides of polygons or faces.
- A border, in an editable poly object, is a connected loop of edges on the open border of an object.
- A face, in an editable mesh, is a triangular plane.
- A polygon, in a poly object, is a face that defines a plane; in an editable mesh, a polygon is a face composed of multiple triangles.
- An element is a polygon that is not attached to a polygonal object.

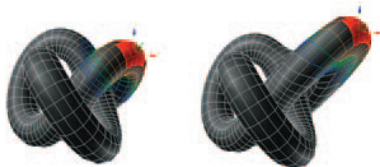
Polygonal objects can be edited by using either the Edit Mesh or Edit Poly modifier. Objects can also be collapsed to editable mesh or editable poly objects. The big difference with editable mesh and editable poly is that poly objects can have polygons with any number of sides, whereas mesh objects are based in triangles. The Edit Poly modifier also has additional selection and editing tools, plus the ability to perform paint deformations and create subdivision surfaces. The editable mesh object is the simplest of the polygonal object types, and is used when precise control over the polygons is needed, such as when creating low-poly models for games. For most applications, editable poly is the preferred geometry because it imposes fewer limitations on the modeler and has a more robust set of tools.

Edit Poly Modifier

The Edit Poly modifier converts an object into an editable poly object. This modifier allows you to reshape the object and to add or subtract detail. In addition, the modifier has controls that aid in texturing an object as well as paint deformation and animation tools.

Selecting components

To select components in an object, highlight the sub-object type (vertex, edge, border, poly, and element) in the Selection rollout or in the stack. After the type is highlighted, you can select the objects by using standard selection tools.



The effect of soft selection on a torus knot

Soft selection

Soft selection allows the current selection to affect a wider area of the model by using a falloff. This allows the selection to be moved, but the rest of the model to deform smoothly as the selection is moved.

Editing vertices

When vertices are the active sub-object, the Edit Vertices rollout appears. These tools are specific to vertices. To delete vertices, simply press the Delete key. This can remove polygons from the object. If you want to remove a vertex without affecting the model, use the Remove button. This button deletes selected vertices and combines the polygons that use them.

Similarly, Break creates a new vertex for each polygon attached to selected vertices, and disconnects the affected edges. Target Weld Allows you to select a vertex and drag it over another to weld the two together. Connect connects two vertices with an edge. Also edges together with additional edges.

Editing Edges

When edges are the active sub-object, the Edit Edges rollout appears. These tools are specific to edges. To delete edges, simply press the [Del] key. This can also remove polygons from the object, so if you want to remove a vertex without affecting the model, use the Remove button.

Editing Polygons

When polygons are the active sub-object, the Edit Polygons rollout appears. These tools are specific to polygons. To delete polygons, simply press the Delete key.

Edit Geometry

The Edit Geometry rollout provides controls for modifying the geometry of the polygonal object, at either at the object or sub-object levels. Geometry can be created, and parts of the object can be hidden. The rollout also allows for objects to be attached or detached.

Polygon Material IDs

The Polygon: Material IDs rollout has controls for applying material IDs to the object and smoothing the object on a per-polygon basis. Material IDs allow multiple materials to be applied to a single object. Materials in a



Torus knot with a particular material applied

Multi/Sub-Object material will be applied to the polygons containing the corresponding ID. Smoothing groups control how the renderer calculates smoothing between the polygons, resulting in a smooth or faceted look.

Modifying Sub-Objects

Standard 3ds Max modifiers can be applied to sub-objects so that they affect only part of an object. An FFD, for example, can be applied to the nose of a character to assist in reshaping it.

To apply a modifier to a sub-object selection, the sub-object must be active when the modifier is applied. The sub-object can be selected by using an Edit Poly, Edit Mesh, or Edit Patch modifier. After the modifier is applied, only the selection will be affected. If needed, you can change the selection or add a falloff by using soft selection to fine-tune the process.

If selection is all that's needed, a Select Poly, Select Mesh, or Select Patch modifier will perform the same task with less overhead.

2.9 Using Subdivision Surfaces

Subdivision surfaces combine the ease of polygonal modelling with the smoothness of a patch surface, giving you the best of both worlds. Subdivision surfaces are used extensively in character animation because they can define almost any complex smooth surface while keeping the underlying geometry light enough to be deformed quickly.

3ds Max has several ways to create a subdivision surface. The MeshSmooth and TurboSmooth modifiers can be applied to any editable poly or editable mesh object. Editable poly objects also have a subdivision surface built into the base object.

MeshSmooth

The MeshSmooth modifier is the most common way of subdividing a mesh. The modifier has several algorithms that it can use to smooth out the mesh. Classic smoothens the mesh to three- and four-sided faces, while Quad Output outputs only four-sided faces. The most robust and commonly used method is NURMS (non-uniform rational MeshSmooth), which allows for much more sophisticated control, such as weighting each control vertex. MeshSmooth also has the ability to apply smoothing in levels, so that part of an object can be smoothed differently than the rest. Iterations control how much the mesh is subdivided. You can select different values for the iterations shown in the viewports and for the iterations that are actually rendered. Because the number of polygons in the object quadruples with each iteration, be careful about using high numbers for iterations.


MeshSmooth allows you to see the underlying polygonal object as a “cage” superimposed on the smoothed object. The vertices and edges of this cage can be selected as sub-objects for the purposes of weighting, which can create creases or sharp edges.

TurboSmooth

TurboSmooth is a simpler way to subdivide surfaces and will do much of the work of MeshSmooth without the overhead. It is much faster and more memory-efficient than MeshSmooth. It simply subdivides the mesh and allows you to set the iterations seen in the viewport and at rendering time. TurboSmooth also has an option for Explicit Normals, unavailable in MeshSmooth.

Smoothing editable polys

An editable poly object also has the ability to subdivide a surface. This option is available only in the editable poly object, but not in the Edit Poly modifier, so in order for this to be used, the stack must be collapsed to Editable Poly. The smoothing algorithm is based on MeshSmooth, and the controls are a subset of the modifier.

Because the smoothing, using Editable Poly happens at the bottom of the stack and works well only for certain types of objects such as those that do not need additional modifiers in the stack. For applications such as character animation, the character is typically smoothed after skin and other deformation modifiers are added to the stack, so smoothing in the base object would not be applicable. 

3 Textures

Textures bring a model and a scene to life. Without texture, 3D models would appear rather dull and plastic. Textures add colour, reflections, transparency, and roughness to a surface. You can create textures from bitmap files containing photographs, drawings, or paintings and also create textures by using tools to automatically generate textures.

3ds Max uses the Material Editor to create materials, which define the character of the surface. Each material can contain various textures, each defining one aspect of the surface, such as colour, opacity, or roughness. Getting a texture to look the way you want can take a lot of revisions, so understanding how the Material Editor works is critical to mastering texturing within 3ds Max. In the production process, many times you create textures along with the lighting, because light has direct bearing on how a surface will look. Using tools such as Activeshade can also help fine tune textures much more quickly.

3.1 Working with Materials

Materials describe how an object reflects or transmits light, and define what the object will look like. A glass object will have a different material than a wooden one. Within a material, texture maps can be used to define the character of the surface, affecting parameters such as colour, opacity, bump mapping, and reflectivity, among many others.



The simple primitive teapot with a material texture applied

Material Editor

The heart of the texturing process is the Material Editor, which is the dialog box you use to create, alter, and apply the materials in your scene.

- Material menu displays options for getting and putting materials to libraries as well as previewing materials and activating or deactivating materials.
- Navigation menu Displays options for moving to and from parent nodes.
- Options menu Displays options for changing the way materials are displayed and organized.

- Utilities menu Displays options to select, condense, and reset materials.
- Materials Displays materials in these slots. Selecting a material slot allows you to edit its parameters.
- Copy Material–Makes a copy of the material so that the current slot can be edited without changing existing objects.
- Get Material–Gets a material from the library.
- Apply Material–Applies the material in the current slot to the selected objects.
- Reset Material–Resets the current material slot to the default parameters.
- Pick Material–Picks a material from an object and places it in the current slot.
- Material Name Indicates the name of the current material. This can be changed by retyping the name.
- Put To Library–Saves the current material to the library.
- Material ID–Indicates the material ID. Each material can have a unique ID, which can be used to add rendering effects such as glows.
- Material Parameters–Indicates the parameters used in editing the material. These will change depending on the type of material selected.
- Sample Type–Allows you to preview your material on a sphere, cube, cylinder, or other object.
- Backlight Shines a spotlight on the back of the material. Useful for transparent and glossy surfaces.
- Background Adds a checkered background, which is useful in visualizing transparent surfaces.
- Sample UV Tiling Changes the tiling of maps applied to the surface.
- Colour Check Checks for video-safe colours.
- Make Preview–Previews materials with animated textures.
- Options–Accesses a menu that changes display options.
- Select By Material–Selects objects that use the current material.
- Material/Map Browser–Brings up the Material/Map Browser window, where materials and maps can be browsed and selected.
- Material Type Selects the type of material to be used.
- Show Material Displays the object's material in the viewports
- Rollouts Provides additional groups of parameters used to edit the material.

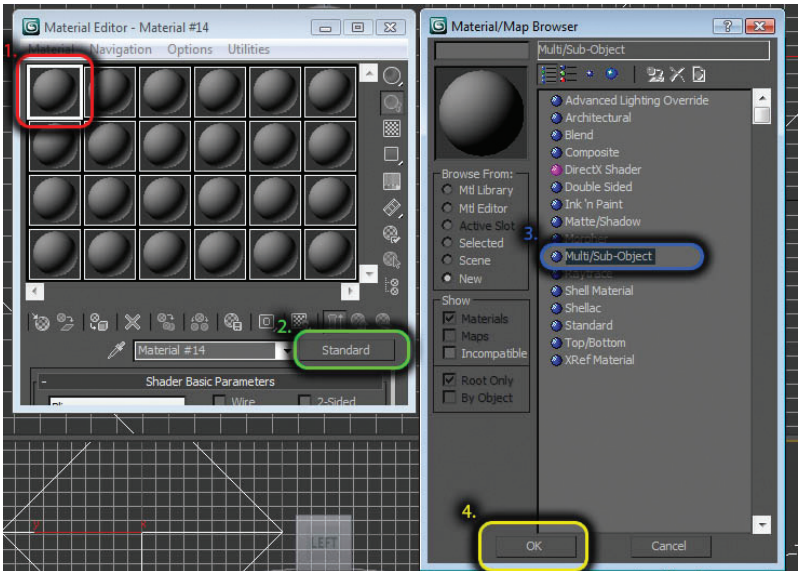
Options Menu

The Options menu allows you to customize the Material Editor. It lets you change the default lighting as well as create custom backgrounds and sample objects. It also has an option to increase the number of active material slots from 6 to a total of 24.

Material/Map Browser

Any time you change or create a material or map in the Material Editor, the Material/Map Browser appears. This window allows you to browse and select materials and maps.

3ds Max can store groups of maps and materials in libraries. Several libraries of common materials are supplied with the software, and these can make a good starting point for authoring your own materials. Many productions build their own custom materials libraries that contain materials specific to a project.



The material map browser

- View Toggling these icons changes the view mode.
- Browse Determines which materials and maps can be browsed.
- Show Toggles the view of materials and maps. Those incompatible with the assigned renderer can also be shown.
- Root Only Shows just the material, not the underlying maps that compose it.
- File Options open, merge, and save material libraries.
- Clear Clears the current library.
- Delete Deletes current material from the library.
- Update Updates the current material to the library.

- Maps Maps show up as rectangular icons.
- Materials Materials show up as rendered spheres.

3.2 Creating and Editing Materials

Creating a material requires several steps. First, you need to decide the type of material to use. 3ds Max has many material types, which cover a wide range of surface types and options. After the basic material is selected, you can add textures and change parameters to fine-tune the material. Each material has its own characteristics, depending on the type of surface and style of rendering. Materials can be added via plug-ins, so the number of different materials you may encounter can be quite robust. This section describes a few of the more common materials used within 3ds Max.

Standard Material

The standard material is the default material used in 3ds Max. It can simulate a wide variety of different surfaces by using different shading types. The shading types are selected by using a pull-down menu, and each type simulates a different type of surface and has its own set of parameters.

Anisotropic simulates surfaces that have directional highlights. Good for such materials as brushed metal, silk and hair.

Blinn: A versatile shading algorithm and probably the most popular among artists. Has fairly soft highlights by default.

Metal: A shader that resembles a metallic surface. Metal shading has a distinct curve for specular highlights. Metal surfaces also have glancing highlights. Metal materials calculate their own specular colour based on the diffuse colour and the colour of the light, so you can't set it.

Multi-Layer: A material that has two sets of anisotropic specular highlights. Good for creating surfaces that are highly polished or have depth, such as automobile paint.

Shader: The standard shader has a basic parameters rollout. This allows you to change the shading type as well as four other parameters. Wire renders the material in wireframe, 2-Sided renders the back side of a surface, Face Map maps a texture once per face of an object, and Faceted removes smooth shading calculations.

Oren-Nayar Blinn: A softer version of the Blinn shader, this is good for non reflective surfaces such as cloth.

Phong: One of the oldest shading algorithms, this creates a surface with distinct specular highlights. Supports reflections and is good for creating shiny artificial surfaces such as plastics and some glass.

Strauss: A very simple shader mostly used to simulate plastic or metal surfaces.

Translucent: Translucent shading is similar to Blinn shading, but it also lets you specify translucency. A translucent object allows light to pass through, and also scatters light within the object. You can use translucency to simulate frosted and etched glass.

Raytrace Material

The Raytrace material uses 3ds Max's raytracer to render its surfaces. Raytracing works by tracing rays of light through the scene, which gives accurate reflections and refractions. This makes it ideal for transparent or reflective surfaces, such as glass or water.

Matte/Shadow Material

The Matte/Shadow material is a special-purpose material used when compositing a 3D scene against existing images or footage. Objects textured with the Matte/Shadow material take on the look of the background image. These objects, however, can cast shadows and create reflections on the matte material, so that they can be used to integrate 3D objects.

Multi/Sub-Object Material

This is not really a material, but a material that holds other materials. Each material has a list of sub-materials, which can be applied to different parts of an object. The parts of the polygon to be textured are configured in the Edit Poly or Edit Mesh modifier. In the polygon rollout, a polygon or group of polygons can be assigned an ID that corresponds to a sub-material slot. These polygons will be textured with the corresponding material.

Architectural Material

The Architectural materials are a robust set of materials that allow you to easily create surfaces used in architectural applications. These include glass, fabric, masonry, and metal, among others. Architectural materials are based on physical properties, so they provide high realism when rendered by using photo metrics and radiosity, allowing architects and designers to create lighting studies with a high degree of accuracy. Architectural materials, however, don't work well with the standard renderer or the light tracer.

Ink 'n Paint Material

The Ink 'n Paint material renders objects with a limited colour palette along

with an ink outline. This good for simulating the look of cel animation or doing illustrative work. The Ink 'n Paint material has controls for the colour of the paint, as well as controls for the colour and quality of the ink strokes.

Mental Ray Material

The Mental Ray renderer will render most of 3ds Max's materials, but when it is assigned as the active renderer, a wider array of material types will become available. These include the Mental Ray material along with many other specialty materials.



A 3D scene with multiple mental ray materials applied

3.3 Using Maps

Almost any parameter in any of the preceding shaders can be configured with a map. Maps can be created from bitmapped images, movie files, or procedurally. Maps can also contain other maps, creating nested trees of maps. When working with maps, you'll need to navigate up and down through the maps and their component maps. You navigate by using the navigation icons in the Material Editor window.

Mapping Colour

One of the more common parameters to map is colour. Most shaders use three parameters for colour: Diffuse, Ambient, and Specular.

- The Specular channel is the colour of the object's highlights. Maps on the Specular channel can give the surface a sense of "roughness."
- The Diffuse channel is the "main" colour of the object. This is where bitmaps or procedural textures are added to give the object its character.
- The Ambient channel is the colour of an object in those places where it is in shadow. Typically, this parameter is locked to the Diffuse channel.

Mapping Opacity

Opacity maps change the transparency of an object. They can be used to create glass- or water-like effects. Varying the transparency by using gradients or falloff maps can give the appearance of varying thicknesses.

Mapping Self-Illumination

Self-Illumination maps create the illusion of incandescence by replacing any shadows on the surface with the diffuse colour. This is good for simulating glowing surfaces and can also be used to remove shadowed areas on an object.

Mapping Bumps

Bump maps give a surface a sense of roughness and depth. Most surfaces are not perfectly smooth, and a little bit of bump mapping can go a long way toward making objects seem real. It is also easier and more efficient to add surface imperfections by using Bump or Displacement maps than to actually model every bump and pockmark on a surface.

Bump mapping only affects the way light interacts with the surface, but does not actually modify geometry; so the edges still appear smooth. Bump mapping is perfectly fine for creating general surface roughness or more-exaggerated bumps on surfaces such as a ground plane or a wall. Bump mapping affects the character of a surface but does not modify the geometry.

Mapping Displacement

Displacement mapping changes the surface of the geometry, adding another level of realism. This process takes more processing and rendering power, so use displacements only where they are needed and use bumps for the rest. Because displacement mapping physically changes the geometry, the spinner to the left of the map is the height of the displacement. Displacement also distorts the actual geometry of the object, so higher-resolution geometry might be needed.

Mapping Reflections

Any shiny object reflects light. Reflections are important in simulating reality. A mirror might reflect an image perfectly, whereas galvanized metal might reflect only broad swaths of colour, but they both reflect at least a little bit of their environment. The most accurate form of reflections comes from using the Raytrace map, but many artists simply use bitmapped environments. Although not as accurate, bitmapped environments can be much faster to render, and, in most cases, reflections do not need to be completely accurate to sell the illusion of reality. If there is no “real” environment, such as when an object is rendered by itself, bitmap environments are a necessity. They are particularly useful when creating animation that integrates with film or video. Artists who work on special effects often take photographs of the film sets in order to generate bitmap reflections.

Mapping Refractions

Refractions are used for semi transparent objects to simulate how light bends, or refracts, through a surface. There are two main ways to calculate refractions in the default 3ds Max renderer: with the Raytrace map and the Reflect/Refract map.

The main parameter to use is the index of refraction (IOR) value. This will change, depending on the type of surface. In the Raytrace material, this is adjusted in the map, while in the Raytrace and Reflect/Refract maps, it is adjusted in the Extended Parameters rollout.

3.4 Types of Maps

3ds Max has a wide variety of maps. These fall into two main categories: 2D and 3D maps. 2D maps contain bitmaps and other types of maps that create images defined by two dimensions, and are mapped by using U and V coordinates. 3D maps also have depth and are calculated volumetrically. They're mapped by using UVW coordinates. Maps can also fall into two other categories, bitmaps and procedural:

- Bitmap textures are derived from image or movie files. These can have a wide variety of formats. Because bitmaps are external files, you need to manage these separately.
- Procedural textures create images by using custom algorithms. These can create all sorts of natural looks and phenomena. You can map them to any object by using UV coordinates, and you can also tile them. Procedural textures can be useful because they can create natural-looking effects quickly and with little overhead. You can also animate procedural textures by keyframing their attributes.

3ds Max has a wealth of procedural textures, and you can add to the list by using third-party plug-ins. Here are a few of the more common procedural textures:

Cellular: A map that simulates natural phenomenon such as mosaic tiles, bumpy skin, pebbled surfaces, and more.

Checker: A map that creates a two-colour checkerboard pattern.

Gradient: A map that creates a linear or circular three-color gradient.

Gradient Ramp: A map that creates a user-definable gradient with as many colours as desired.

Noise: A map that creates Gaussian or fractal noise. **Smoke** A map that simulates smoke. It is usually used to create opacity maps for clouds and other smoky effects.

Splat: A map that simulates splattered paint. **Swirl** A map that creates a swirl effect.

Tiles: A map that simulates a wide variety of tiling and brick patterns.

Falloff: A map that changes colour depending on the angle of view. This is really good for simulating transparencies as well as surfaces such as silk.

Applying Materials

After a material is created, it can be applied to an object. Applying a material is as simple as right-clicking and dragging it from the Material Editor window to the object. The Assign Material icon or menu option can also be used to assign a material to the selected object or objects.

Mapping

In order for a material to appear on a surface, it needs to be mapped. Most objects in 3ds Max have default mapping coordinates assigned, but many times these will not suffice. 3ds Max has several tools to modify an object's mapping coordinates.

Coordinates Rollout

The first way to modify how a texture will map is within the texture itself. Every map will have a coordinates rollout, which adjusts how the map is applied to the surface. It allows you to tile a map, move and rotate a map relative to the surface, and mirror a map, among other tasks.

UVW Map

The next most common mapping method is by adding the UVW Map modifier to the stack. This modifier can map a texture to an object in several different ways. Just as with any modifier, the UVW Map modifier can be used to affect sub-objects. This allows you to map different parts of an object with different mapping coordinates. To do this, simply add an Edit Poly or Select Poly modifier in the stack, and select the polys you want to map. Leave the sub-object open and add the UVW Map modifier to map just the selected sub-objects. Mapping can be adjusted by using the parameters in the modifier. The gizmo can also be selected and manipulated by moving, rotating, and scaling.

- Planar Maps the image to a projection plane
- Cylindrical Maps the image to a cylinder
- Spherical Maps the image to a sphere Shrink Wrap Maps the image to a sphere, but without pinching the poles
- Box Maps the image to the six faces of a box
- Face Maps the image as one image per face

Unwrap UVW

One of the big benefits of polygonal modelling is that polygonal objects can have branches and multiple surfaces. This, however, makes it difficult to texture them with simple projections or 2D image placement.

The Unwrap UVW modifier is the best way to edit texture mapping on a complex polygonal object. It allows you to lay a wireframe representation of the object against a texture map and place textures exactly by adjusting the positions of the object's UV coordinates. The texture map contains images for all parts of the object. This map is placed inside a material and applied to the object.

The UVW Editor

Map Selection – Selects a map to display in the viewport.

View menu – Options to pan and zoom within the viewport.

Display menu – Options to hide, freeze, and show various parts of the viewport.

Options menu – Options for setting defaults.

Navigation tools – Tools to navigate the Editing viewport.

Rotate 90 – These will rotate the current selection by 90 degrees.

File menu – Options to load, save, and reset UVW coordinates.

Edit menu – Commands that provide access to the different transform functions, and copy-and-paste selections.


Select menu – Commands that let you copy a viewport selection to the editor, and transfer selections among the three different sub object modes.

Move/Rotate/Scale – Tools to let you move, rotate, and scale selected parts of the object. Editing viewport This is where the mapping of the object is matched to the bitmap. This can be navigated like a standard orthographic viewport.

Soft Selection – Tools to soft-select the geometry of the object.

Selection modes – Options to select by vertex, edge, or polygon. You can also select by element and paint selections.

Mapping menu – Lets you apply automatic, procedural mapping methods to a model. Each method provides settings so you can adjust the mapping to the geometry you're using.

Tools menu – Tools on this menu let you flip and mirror texture coordinates, weld vertices, combine and separate sets of texture coordinates, and sketch outlines for multiple selected vertices. 

4 Lighting



Any photographer will tell you how important lighting is when taking a photograph. In the basic sense, photography is nothing more than capturing and recording light. Artists working in 3ds Max also use light, but because 3ds Max uses a digital representation of light, you can do things with light that are impossible in nature. In 3ds Max, you can switch a light's shadows on or off, vary the intensity of light according to distance, and create lights that actually remove light from a scene. 3ds Max also provides methods to create highly realistic and natural lighting, simulating the way real light propagates through an environment. These tools give you the freedom to create the real world or your own world.

4.1 Lighting adds up

Materials describe how an object reflects or transmits light, and define what the object will look like. A glass object will have a different material than a wooden one. Within a material, texture maps can be used to define the character of the surface, affecting parameters such as colour, opacity, bump mapping, and reflectivity, among many others.



Lighting makes all the difference

4.2 Creating Lights

The various types of lighting can be accessed by choosing Create > Lights or by selecting the light icon in the Create panel. 3ds Max has two main categories of lights: standard and photometric. The types of lights you select will depend on the application and type of renderer you select. Standard lights are used with 3ds Max's scanline renderer and with the Mental Ray renderer. They are the choice for animation and most other applications. Photometric lights are used with the scanline renderer's radiosity feature to create accurate lighting for architectural applications.

Light Parameters

Standard lights have the same parameter rollouts used to create and define the character of the light. Standard lights are used for most applications and can create a wide range of lighting, from highly realistic to highly stylized. Architectural applications need highly accurate lighting that simulates the real world. Photometric lighting is perfect for creating these types of images.

There are options to set the type of light, turn it on/off, and create a target for aiming the light. Other options include options to set the type of shadow as well as options to turn shadows on or off. There is also a value that multiplies the intensity of the light. This value can be negative to remove light from the scene. Values are used to attenuate the light close to the source. The Exclude button brings up a dialog box that allows the light to illuminate only specific objects in the scene.

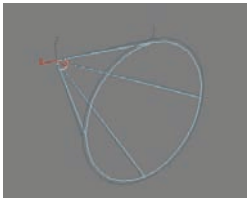
Types of Lights

Different parts of the scene may need different types of lights. Some parts of

the scene may need a general wash of light, while others may need a spotlight directed at a specific object. 3ds Max provides a wide collection of lighting types to fit all needs.

Spotlights originate from a single point and spread outward in a conical shape. 3ds Max has two types of spotlights: Target Spot and Free Spot. The only difference is that a Target Spot has the target attribute turned on, which creates a target that the user can manipulate to control the direction of the spot. Spotlights can illuminate both diffuse and specular areas of a scene. They also can cast shadows and decay over distance. Hotspot/Beam adjusts the size of

the entire light; Falloff/Field controls the softness of the edge of the light cone. Spotlights can be either circular or rectangular.



Spot lights

the specularity of an object and can cast shadows. The best use for an omni light is as an overall scene light.

Directional lights are similar to spotlights in that they have a specific direction, but a directional light does not emanate from a single

point. Instead, the rays are parallel and simulate distant lights such as the sun. This makes them ideal for outdoor scenes. This light also comes in two varieties, Target Direct and Free Direct, the only difference being the target.



Directional Light

Omni lights can be thought of as bare light bulbs in the room. Like a light bulb, an omni light sends its rays in every direction. Similar to spotlights, omni lights affect the



An omnilight in a scene

Area lights cast their light from an area, rather than from a point. These are only available only to the Mental Ray renderer. This makes them a good choice for simulating diffuse lighting, bounce lights, or fluorescent tubes. Although area lights can provide realistic effects, calculating complex shadows can eat up a lot of render time.

Mental Ray Lights

Directional, point, and spotlights in 3ds Max can be used with the Mental Ray for 3ds Max renderer, and most 3ds Max lighting parameters translate with no effort. Each light has rollouts for the mental ray options, which control indirect illumination and light shaders. Indirect illumination in mental ray simulates the way light naturally moves through a scene. Global illumination (GI) simulates how light bounces off surfaces in a scene and can create very soft and realistic renderings. Caustics simulate the way light transmits through an object or reflects off it. Light shaders are custom plug-ins for mental ray that affect the light's behaviour for creating special effects.

Skylights are a special type of light that simulates natural diffuse lighting. This light is great for adding realism to a scene, but it does take longer to render. When using a skylight, the Light-Tracer must be turned on in the Render Scene dialog box.

Adjusting Lights

Lights can be manipulated by using the Modify panel or directly in a viewport. Lights can be aimed and positioned by using the Move and Rotate tools, and if a light has a target, the target can be moved as well. The Select And Manipulate tool can be used to adjust the cone angle and rotation of a spotlight or direct light.

4.3 Creating Shadows

Almost all objects cast shadows, and creating realistic shadows is one of the keys to truly simulating reality in 3ds Max. Shadows not only add realism, but contribute greatly to the mood of a scene; they help the eye determine the placement of objects in a scene, and they visually anchor objects to the ground.

Shadow Parameters

Parameters affecting all types of shadows can be adjusted with the Shadow Parameters rollout in the light's Modify panel. These parameters affect the colour of the shadow as well as the density of the shadow. You can also have atmospheric effects cast shadows.

Depth Map Shadows

Depth map shadows are used extensively by artists because they render quickly. Though not quite as precise as raytraced shadows, they're great for most general shadowing applications. 3ds Max creates a depth map shadow by rendering

one or more bitmaps showing the depths of the scene from the light's point of view. 3ds Max will then compare these bitmaps with the objects in the scene to determine which areas are in the shadow. To control this process, 3ds Max provides a Shadow Map Params rollout to adjust these parameters.

The two most important parameters to understand when working with depth map shadows are the Size and the Sample Range parameters. The Size parameter determines the size of the shadow map, which covers the width of the light cone. The Sample Range parameter controls the soft edge of the shadow. The larger the size of the shadow map, the more accurate the shadow. The larger the sample range, the more softening. Softening, however, is relative to the resolution, so larger size maps require more filtering to get the same softness. Although large maps are more accurate, they take up more memory when rendering. The size of the map depends on the cone angle of the light. If the light covers an area the size of the image, the depth map should be approximately the size of the image. Sometimes smaller maps are preferred, because they can produce softer shadows with less filtering.

There are other parameters you can set in this rollout. Two sided shadows will render shadows for both sides of a surface. Bias is a parameter that offsets the shadow from the object by a small amount to ensure that the shadow is behind the object. If the parameter is too low, parts of the shadow will render in front of the object. If it is too high, the shadow will be offset from the object.

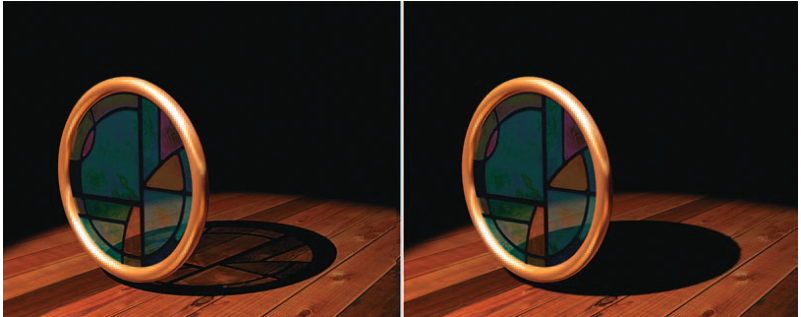
Raytraced Shadows

Raytraced shadows work by tracing the actual beams of light through the scene. This is more computationally expensive than simple depth map shadows, but raytraced shadows prove to be more accurate. They can create shadows for transparent objects, and they are also easier to set up, because you do not have to calculate map sizes. 3ds Max has two types of raytraced shadows: regular and advanced. The Advanced Raytraced Shadows option has additional parameters for controlling the look of the shadow.

The Ray Traced Shadow Params rollout has options to control the bias of the shadow, which is very similar to the bias control on depth map shadows. You can also use this rollout to turn on two-sided shadows.

Advanced Raytraced Shadows

Advanced raytraced shadows are an improvement on standard raytraced shadows. These shadows have additional parameters to control the



Raytraced shadows (left) render shadows through transparent objects, but depth map shadows (right) won't.

softness of the shadow, along with controls to optimize transparency and shadow calculation.

4.4 Creating Lighting Effects

Lighting Effects add realism to the way the light illuminates the scene. Adding decay and attenuation simulates the way a real-world light's energy falls off with distance. These parameters can also be used to play with reality and place or remove light from the scene.

Decay

By default, lights in 3ds Max illuminate all objects equally, no matter how far they are from the light. In the real world, however, the intensity of a light decays with distance. To create more natural lighting that falls off over distance, you can select Decay in the light's Intensity/ Colour/ Attenuation rollout. There are two types of decay:

- Inverse falls off directly with distance.
- Inverse Square falls off as the square of the distance. This is the same as real-world lighting.

When decay is added to a light, you almost always need to increase the intensity of the light to illuminate the scene. When using Inverse Square decay, you may have to increase the light intensity by several orders of magnitude to illuminate the scene. One way to offset this is to use the Start parameter, which specifies a discrete distance from the light where the decay starts.

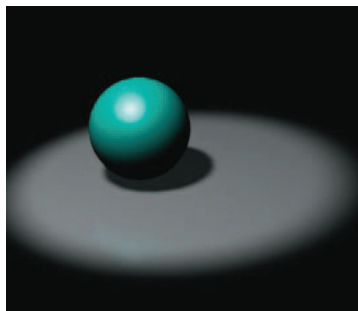
Attenuation

Another way to control the way light changes over distance is to use near and

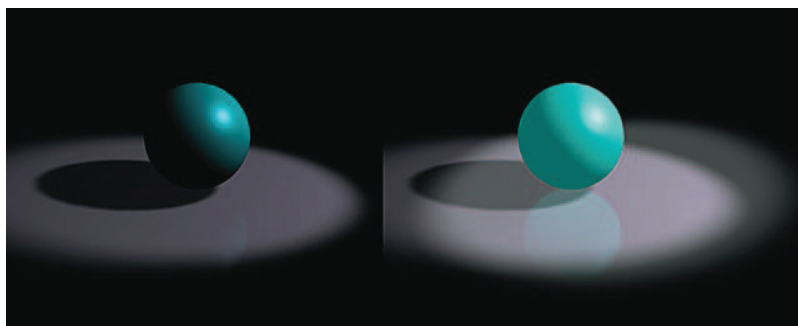
far attenuation. These are much more controllable than just simple decay and allow you to set ranges for the decay of the light when it gets close or far from the source. Attenuation is terrific for putting light into specific places in a scene.

Advanced Lighting Effects

The Advanced Effects rollout contains additional parameters to control the character of a light. Lights can be configured to have more contrast or to soften, as well as to illuminate only ambient, diffuse, or specular parts of the scene. These effects can be handy when lighting a scene, because you can configure a light to add contrast, softness, or ambient lighting to anything it illuminates.



Basic lighting on a sphere contains diffuse and specular lighting.



Effects are best used in conjunction with other lights. In this case, a standard spotlight is used (left) and an ambient-only spotlight is added (right) to brighten up the dark spots on the sphere.

Lights can also be used to project images on parts of the scene, much like a slide projector. This is accomplished by using a map in the Colour channel. This can be anything from a bitmap to a procedural texture, such as a ramp.

Atmospheres and Effects

3ds Max offers several ways to add special effects to lights. These effects can be loaded by using the Atmospheres & Effects rollout in the light's Modify panel. Each light can have multiple effects added, and third-party effects can also be loaded as plug-ins. 3ds Max comes with two ways to affect a light: volume lights and lens effects.


Volume Light

One way to make lights more visible is to use volume light, which simulates the effect of light through a dusty or smoky room. Volume light can be used on spotlights, direct lights, or omni lights. Fog in a spotlight takes up a cone shape, but omni light fog can have a specific radius and falloff, for creating fog in a specific volume.

Lens Effects

Many times you need to make a light source visible. To do so, you use 3ds Max's Lens Effects, a suite of effects that allow you to add effects such as glow, halos, and lens flares to a light. Like Volume Lights, Lens Effects are added by using the Atmospheres & Effects rollout in the light's Modify panel. The Lens Effects main window has tools to globally control the size of the effect as well as to render tests.

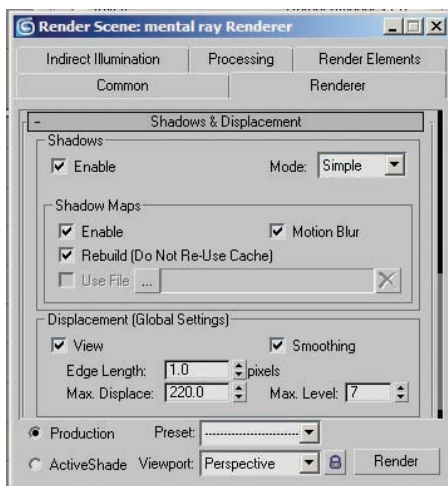
Setting Light Exclusion

Light exclusion gives you precise control over lighting on an object-by-object basis. Lists of objects can be excluded from a specific light or can be included. This gives you many ways to customize how lights affect the scene. The window is accessed by clicking the Exclude button on the light's General Parameters rollout. 

5 Rendering

Rendering is the process whereby your 3ds Max scenes come together into an image. Just as you print film in the darkroom, you truly create an image by rendering it. Creating good renders involves knowing a little bit about the technology behind the scenes, such as the way lights and cameras interact, as well as the way 3ds Max and mental ray smooth and antialias images. Although knowing the technology can get you to the point where you can

render almost anything, it's your artist's eye that puts this knowledge to use and makes the difference between a good image and a truly great one.



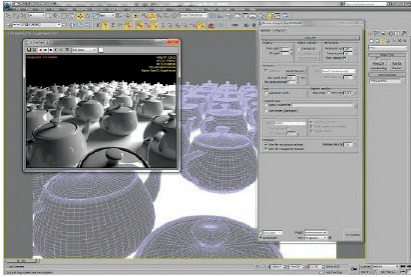
Rendering will make your artistry a reality

5.1 Renderers

3ds Max has two basic renderers that come with the software: the scanline renderer and mental ray. The type of renderer is selected by using the Assign Renderer rollout of the Render Scene dialog box. 3ds Max's scanline renderer is a fast and robust rendering solution. It produces excellent images and can create advanced effects such as radiosity for architectural and design applications. Mental ray is an industry standard renderer that is used by various other packages. It provides advanced lighting simulations to create global illumination and caustics. Most 3ds Max lights, cameras, and materials will work with both renderers, though each renderer has its own set of tools for those areas that don't overlap. Rendering can be started by using the render icons on the main toolbar.

ActiveShade renders the scene in the ActiveShade window, which allows for interactive rendering

Quick Render renders the scene by using the current settings. Render Type allows you to render the view, selected objects and regions. Render Scene brings up the Render Scene window.



ActiveShade

5.1.1 Render scene window

Much of the rendering process in 3ds Max is controlled in the Render Scene window (choose Rendering > Render). This window has several tabs. The first is a Common panel that you can use to specify the size and format of the render, the filenames, and other options. It also lets you assign the renderer.

The Renderer tab is unique to the type of renderer selected. Other tabs will also appear, depending on the type of renderer selected.

5.1.2 ActiveShade window

ActiveShade provides interactive rendering for 3ds Max. ActiveShade updates the render as parameters such as lighting and materials are changed. A floating ActiveShade window can be created by using the ActiveShade icon on the main toolbar. Viewports also have an option to be displayed as ActiveShade. You can drag and drop materials from the Material Editor to an ActiveShade window as you can with other viewports.

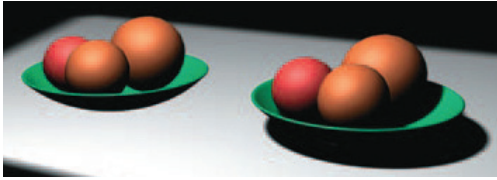


ActiveShade window

ActiveShade does have a few limitations. Only one ActiveShade window can be active at a time. Changes to geometry will not update in the ActiveShade window, and it will not render atmospheric effects, rendering effects, or raytraced shadows.

5.2 Object properties

Each object in the scene has object properties applied to it. Some of these options determine how the object appears in the scene, but they also control how the object is rendered. To access the Object Properties panel, go to Edit > Object Properties, or by right-click on an object (or objects) and select Object Properties from the object's quad menu.



Objects rendered with (right) and without (left) shadows

5.3 Cameras

Cameras in 3ds Max are similar to real-world cameras. In addition to controlling what you see through viewports, they allow you to take virtual photographs, or renders, of

a scene. Cameras in 3ds Max have controls such as focal length and aperture as well as f-stop and shutter speed for creating effects such as depth of field and motion blur. 3ds Max cameras, however, don't use film, so shutter speed and f-stop do nothing to affect the exposure of the image.

5.3.1 Types of cameras

Although all cameras in 3ds Max share the same sets of attributes, you'll see two types of cameras listed when you choose Create > Cameras or select the Cameras tab from the Create panel. You will find as Free Camera and Target Camera; the only difference between these cameras is that the target camera is aimed at a target object. Free Camera is a basic camera that can be controlled by using translation and rotation. Target Camera always points to the target. This makes positioning the camera simply a matter of translating the camera and the aim point, rather than rotating the camera. This can be useful when the camera is following a moving object. If the aim point follows the object, the camera will too.

5.3.2 Focal length

The focal length of a lens determines the distance it takes for the lens to focus the image to a point.

Focal length and angle of view are set by using the camera's Parameters rollout. This is also where you set clipping planes.

The closer the focal point is to the lens, the wider the angle of view. For example, an extremely short focal length creates a fish-eye effect. A standard wide-angle lens reduces this effect and a 50mm lens is one of the most common and is good for most general applications. Longer lenses can be good for portraits, but at very long lengths, the lens might flatten the scene too much. Shorter focal lengths mean that objects must be closer to the camera to fill the field of view.

Quick fact

The focal length of a lens determines the duration of the scene that can be focused, also called the field of view (FOV). In 3ds Max, these two parameters are directly linked: as the Lens option increases, the FOV option decreases.

Extremely short focal lengths can distort the perspective of a scene, and long ones tend to flatten it.

5.3.3 Clipping planes

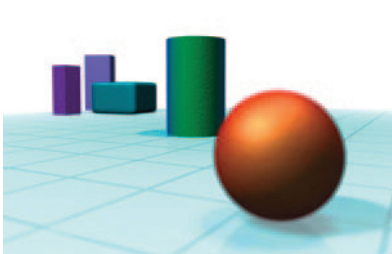
Clipping planes define the distances over which the camera will work. This is toggled on by using the Clip Manually option. Clipping planes can, however, be used for various tasks, such as dividing a scene into layers for rendering. You might also want to adjust a clipping plane manually when you are modelling. For example, you might need to work on part of a model in wireframe without being distracted by all the vertices on the back side of the model. By setting the clipping plane close to the working plane, you can hide the far side of the model.

5.3.4 Depth of field

Depth of field simulates how a real-world camera focuses. Focus is important in cameras because it allows the photographer to guide the viewer's eye to the important parts of the scene. Cameras tend to focus objects in a range of distances. A low depth of field means the range is narrow; fewer parts of the scene will be in focus. Conversely, the higher the depth of field, the more of the scene will be in focus.

3ds Max has several ways to create depth of field, depending on the renderer used. The scanline renderer has Depth of Field as a multi-pass effect or as a rendering effect. Mental ray has its own tools available in the Render Scene dialog box.

The multi-pass Depth of Field effect is created by toggling on the effect in the camera's Parameters rollout. The actual parameters for the effect are located in the Depth of Field Parameters rollout. Multi-pass effects are created by rendering the scene in several passes and then averaging the



Camera targeting cylinder



Camera targeting sphere

results. These effects can also be previewed in viewports. The downside of using multi-pass effects is that they can slow rendering significantly, because each pass requires that each frame be completely rendered (so 12 passes will render 12 times as slow).

The Depth of Field render effect is applied by choosing Rendering > Effects and adding the

Depth of Field effect to the Effects list. Render effects are post-processing effects, so the scene is rendered by the scanline renderer before the effect is applied. Depth of Field works by calculating the depth of each pixel in the rendered scene, and then dividing the scene into foreground, background, and in-focus pixels. The foreground and background images are then blurred, and the final image is composited from the processed originals.

Depth of field in mental ray is much more precise. It is similar to how depth of field is calculated in a real camera, in that mental ray uses an f-stop parameter to control the amount of blurring. Setting up depth of field is similar to the multi-pass effect; the camera's target distance determines the focal plane of the camera. In mental ray, motion blur is configured by selecting the Depth of Field (mental ray) option in the Multi-Pass effect. When this is selected, the Depth of Field parameters give you one option to set the f-stop. The f-stop parameter controls the amount of blurring at distances away from the focal plane. In a real-world camera, the f-stop measures the size of the lens's aperture. The lower the f-stop value, the larger the aperture and more the blurring. Mental ray works the same: lower numbers enhance the effect; higher numbers attenuate it.

5.3.5 Motion Blur

Another camera effect is motion blur. In the real world, it takes time to expose a frame of film. If the subject moves during this exposure time, the resulting image is blurred. In 3ds Max, there is no such thing as film speed, so motion blur has to be simulated. This is done in several ways, depending on the renderer. 3ds Max's scanline renderer has three types of motion blur: Image, Object, and Multi-Pass.



Effect of motion blur while rendering

Object and Image motion blur are configured on a per-object basis by using the Object Properties panel. Select an object or objects and right-click to produce a quad menu, which will have an Object Properties option. After you access the Object Properties panel, you can enable motion blur as well as choose the type of motion blur for the objects.

Multi-Pass motion blur is a camera effect and is used primarily to simulate the blur caused by a moving camera. It is configured in the camera's Multi-Pass Effect panel. The Motion Blur options in the Object Properties panel. The type of motion blur can be selected, and a multiplier can be set to enhance or dilute the effect for the object. Image motion blur is a post-render process that simply blurs the pixels of the scene. It renders quickly, but the results are not completely accurate. It does not perform well with overlapping objects, objects that change shape, or reflections. Image motion blur is also configured in the Render Scene dialog box, via the Renderer tab. The options set the duration of the effect as well as whether transparency will be considered. Object motion blur is configured in the Render Scene dialog box, via the Renderer tab. The options set the duration of the effect as well as the number of samples. A low number of samples can cause artefacts (left). A higher number of samples will be smoother but will take longer to render.

5.3.6 Motion Blur in mental ray

Motion blur in mental ray is more robust than 3ds Max's motion blur. Mental ray blurs anything in the scene: shaders, textures, lights, shadows, reflections, refractions, and caustics. Mental ray uses the camera's shutter angle to determine the amount of blur. This is modified on the Render Scene dialog box's Renderer tab, by using the Motion Blur attributes in the Camera Effects rollout:

Shutter Duration indicates the duration of the shutter in the scene. Higher numbers enhance the effect. Shutter Offset offsets the shutter. A zero value starts the shutter at the start of the frame. Motion Segments indicates the number of samples to use when calculating blurs. Higher numbers are more accurate at the cost of render time. Time Samples controls the number of times the material is shaded during each time interval. Rapid changes in reflections or refractions might require a higher Time Samples value.

5.4 Scanline renderer

3ds Max's scanline renderer is the default renderer for the software and is a

good general purpose renderer. It's the renderer used in most of this book, so you've already had some experience with it. 3ds Max's scanline renderer is also the most tightly integrated renderer available to 3ds Max, and any feature in the renderer can be connected seamlessly with any other feature in 3ds Max. The renderer supports both scanline and raytracing, so only those parts of the scene that need the extra processing power of raytracing receive it. When 3ds Max Software is the chosen renderer, all its options are controlled through the 3ds Max Software panel in the Render Scene window.

5.4.1 Antialiasing

Area - Computes antialiasing by using a variable-size area filter.

Blackman - A 25-pixel filter that is sharp but without edge enhancement.

Blend - A blend between sharp area and Gaussian soften filters.

Catmull - Rom A 25-pixel reconstruction filters with a slight edge-enhancement effect.

Cook Variable - A general-purpose filter. Values of 1 to 2.5 are sharp; higher values blur the image.

Cubic - A 25-pixel blurring filter based on a cubic spline.

Mitchell-Netravali - Two-parameter filter; a trade-off of blurring, ringing, and anisotropy. Setting the ringing value higher than 0.5 will impact the alpha channel of the image.

Plate Match/MAX R2 - Uses the 3ds Max 2 method (no map filtering) to match camera and screen maps or matte/shadow elements to an unfiltered background image.

Quadratic - A 9-pixel blurring filter based on a quadratic spline.

Sharp Quadratic - A sharp 9-pixel reconstruction filter.

Soften - An adjustable Gaussian softening filter for mild blurring.

Video - A 25-pixel blurring filter optimized for video applications.

5.4.2 Raytracer

Raytracing in the scanline renderer allows it to create highly realistic reflections and refractions. Raytracing works by tracing rays of light from the camera throughout the scene. Raytracing is configured in two places. First, the material must be a Raytrace or another type of material with Raytrace maps in the reflection or refraction channels. Second, the renderer must have raytracing enabled. The raytracing tab is in the Render Scene window.



Paint raytracer

When the depth is set to 0, one object can reflect another, but not much else. Adding more reflections allows objects to reflect one another's reflections, adding to the sense of realism. The number of refractions needed in a scene can add up quickly.

5.4.3 Advanced lighting

Advanced Lighting in the scanline renderer re-creates the way real light scatters through the scene. There are two ways to render advanced lighting effects: by using the Light Tracer or using Radiosity.

The Light Tracer creates soft-edged shadows and simulates colour bleeding for brightly lit scenes. The Light Tracer does not attempt to create a physically accurate model and can be easier to set up than radiosity. The Light Tracer works well with most lights, but adding a skylight will create softer shadows.

5.4.4 Radiosity

Radiosity is more complex than the Light Tracer but is also physically accurate. Radiosity scatters light energy throughout the scene, calculating the light intensity for all surfaces in the environment. It is mostly used for architectural renderings, but can be used for animation. Radiosity relies on the photometric lights in



A scene rendered with radiosity

3ds Max to create its effect. Photometric lights are physically accurate, so they must be placed in a physically correct manner.

Radiosity in 3ds Max works by creating a radiosity solution, which calculates a map of how the lighting affects each and every surface of the scene. If the objects in the scene remain still, the solution can be used for any camera angle. This makes it very useful for an architectural fly through. If any object in the scene moves, however, then the radiosity solution must be recalculated. This can slow rendering significantly when radiosity is used for animation.

5.5 Environment and Effects Panel

The Environment and Effects panel allows you to control such things as the

background colour, global lighting, exposure, and environmental effects. It is accessed from the main menu by choosing Rendering > Environment.

5.5.1 Background

The background of the scene can be configured by using the Environment map. The background can be a colour or a map. The map can be a bitmap or any 3ds Max 2D procedural map. The map can be dragged into the Material Editor as an instance to set mapping styles. The map defaults to screen mapping, which simply stretches the map to fill the screen. You can also map it as a spherical, shrink-wrap, or cylindrical environment.

5.5.2 Exposure Control

Exposure Control is a process that allows you to fine-tune an image as it is rendered. This process can be used for any scanline-rendered scene. It treats the rendered image like a film negative and allows you to adjust exposure the way film lets you. It can be helpful in matching rendered scenes to live action. Those who use radiosity will find that exposure control is almost a necessity. Radiosity rendered scenes can have a wide dynamic range and exposure control can help bring this wide variation in lighting into a more-useable image.

5.5.3 Environmental effects

Environmental effects are added by using the Effects rollout at the bottom of the environment panel. Environmental effects are volumetric (such as fog and fire). Effects can be stacked in the Effects list, and the effects will be evaluated from bottom to top. Fog causes objects to fade as they recede from the camera. The Environment Ranges settings in the camera control how the fog is rendered. Volume Fog creates fog within a specified volume. It is good for creating misty environments or cloudlike effects. A gizmo helper object specifies the volume for the effect. Fire Effect can produce animated fire, smoke, and explosion effects. It can be used for fire, explosion, and nebula-type



Recreate trees with environmental effects

effects. Fire effects are controlled by gizmo helper objects, which are used to place and scale the effect. Multiple fire effects can be added, so their order in the Effects list becomes important. Fire does not create light or shadows, so it is common to create a light that simulates this part of the effect. The effect is controlled by a gizmo helper, and light is provided by an omni light.

5.6 Mental ray renderer

Mental ray for 3ds Max is an excellent renderer that has become a standard at many studios around the world. Mental ray can render scenes by using its own scanline algorithm (not to be confused with 3ds Max's default scanline



Mental Ray diamonds

renderer) and it can also ray trace. Mental ray can be more robust than 3ds Max's scanline renderer when it comes to creating highly realistic effects. Global Illumination allows mental ray to simulate the way light bounces off diffuse surfaces, much like Advanced Lighting within the scanline renderer. This can create a much softer and more-realistic scene. Caustics simulate the way light reflects or passes

through complex objects and can simulate materials such as glass, water, and reflective metals. Mental ray also has a robust library of material types that can simulate surfaces such as glass, skin, and car paint.

3ds Max has fairly tight integration with mental ray, meaning much of it is invisible to the average user. Shaders, lights, and cameras from 3ds Max transfer over to mental ray with little effort. For additional control, cameras, lights, objects, and shaders all have mental ray attributes that become active when mental ray is used as the renderer. Additional mental ray rendering features such as Global Illumination and Caustics can be used on most 3ds Max scenes as well. Basic controls over the mental ray renderer are located on the Render Scene window's Renderer tab.

5.6.1 Global illumination

Global illumination is a rendering method used to create highly realistic lighting and shading. It simulates the actual scattering of photons of light around the scene. Although it is computationally expensive, the results are

often worth the extra processor time. Global Illumination is controlled in two places. First, the light must be set up to cast photons; then the renderer must be configured to accept these photons and render the results.

5.6.2 Photons

There are two main lighting parameters to consider when setting up global illumination: energy and number of photons. Energy is the brightness of the light, so more energy produces a brighter global illumination solution. The number of photons is similar to a sampling rate and affects the quality of the image. More photons produce more accurate results, but at the cost of additional render time. For physically accurate renders, the number of photons can get incredibly high (into the millions). For example, when the number of photons is low, individual spots of light can be seen. As the number of photons increase, they start to blend and eventually overlap, and the illumination can be seen. When using just photons to illuminate the scene, it can take millions of photons to completely smooth out the graininess.

5.6.3 Energy

The second major attribute used to calculate global illumination is energy. This is roughly equivalent to a light's brightness. Photons, however, perform only indirect lighting, so increasing energy will increase only the amount of indirect light in the scene. Getting the right illumination requires getting the correct balance between the direct light and indirect light.

Energy is sensitive to the scale of the scene. Larger scenes need much larger energies to get the same amount of lighting as a smaller scene. In addition to the scale of the scene, energy also works in conjunction with the decay value, which determines how quickly the energy dissipates in the scene. A decay of 2 creates an inverse square falloff, which simulates the way real light illuminates a scene. Lower values create more light; higher values attenuate the light.

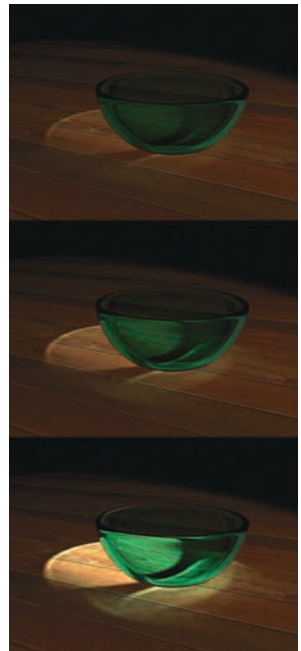


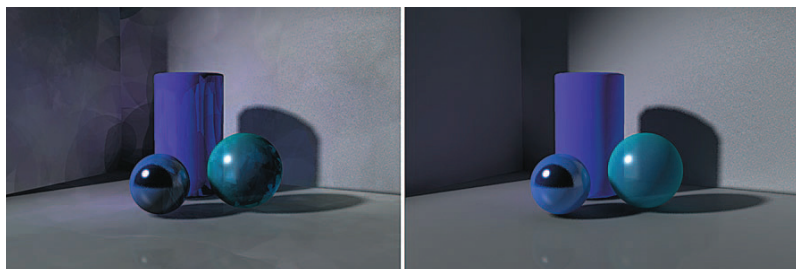
Image rendered with Decay = 2 and energy 4000, 8000 and 16000 respectively from top to bottom

At low intensities, photons don't do much to provide additional illumination. Increasing the photon intensity adds diffusion to the scene. At very high intensities, the diffuse light from photons begin to overwhelm the direct light in the scene. With the direct light's intensity turned down to 0, indirect light created strictly by the scene's photons can be seen.

5.6.4 Final Gathering

Final Gathering is used as a finishing tool for Global illumination and can help reduce the need for high numbers of photons. In its simplest sense, it can be used as a blending algorithm, and it smoothens and interpolates the light created by the photons to simulate a radiosity solution.

Final Gathering is similar to raytracing. While raytracing traces light rays from the camera's point of view, Global Illumination starts at the light source and traces from there. Final Gathering rays are emitted from a light; when they hit a surface, mental ray calculates the way the rays are scattered, along



Global Illumination photons are plainly visible in this scene (left); many more photons could be added, but at the cost of rendering time. Final Gathering smoothens out the graininess in this scene (right), creating a good final result.

with their new energies. This process is continued, and the secondary rays of light continue to bounce off other surfaces and so on, creating a soft and realistic lighting of the scene.

5.6.5 Caustics

Caustics simulate the way light refracts through a complex surface or reflects off it. Caustics are useful in simulating such surfaces as water, glass, and metals. Working with caustics can be slightly tricky because several variables affect the way the final render looks. The photon intensity, the exponent of the falloff, distance of light source, number of photons, and the materials of the objects all affect the outcome.

Energy is probably the most important value when generating caustics. The intensity of caustics pretty much follows the energy of the photons. When the value is too low, the caustics appear faint, but high numbers can easily blow out a render. The position of the light is another important value to consider. By default, photon intensity decays at the square of the distance from the light. This means that placing the light twice as far away reduces the intensity of the photons by a factor of four.

Conversely, moving the light twice as close quadruples the intensity. Finally, the Decay attribute also plays a factor in how the caustic is generated. This number represents the exponential value at which the light energy decays. Generally, this is kept at the default of 2, which simulates the inverse square law and real-world lighting, but lower numbers can extend the power of the light, and higher numbers will limit it.

5.7 Render Elements

The Render Elements tab of the Render Scene window lets you separate out different parts of the render and save them into individual image files. This can be useful when you composite images or work with image-processing or special-effects software. Rendering such elements as shadows or specularly to separate files allows you to adjust their levels inside a compositing package to achieve a more-seamless integration of 3D with live action or other rendered elements.

5.8 Backburner

Backburner is an excellent batch and network rendering utility for 3ds Max. It allows you to set up a render farm of multiple machines and manage multiple renders. Backburner is a separate application from 3ds Max and must be started from the Windows Start menu. Backburner has three main programs: manager, server, and monitor. These are located in the Start menu, under Autodesk/Backburner.

When rendering within 3ds Max, Backburner can be accessed by toggling the Net Render box in the render output section of the Render Scene window. This brings up a window where you can assign the render job to specific servers.

Network rendering is started in three steps:

1. The network manager program is started on one machine.
2. The render servers are started on the rest of the machines.
3. Jobs are submitted.

All machines that are part of the render farm need to have installed a full version of 3ds Max or just the 3ds Max core if the machine is only a render node. Jobs submitted to the network must be submitted from a machine that has a full authorized copy of 3ds Max. In addition, all machines that render must have access to a common network server that can receive the rendered frames.

5.8.1 Manager

The manager program controls all render servers in the network. There is typically one manager machine per network. This program must be active and running for network rendering to be active. When the program is run, the manager window will appear on the machine. By choosing Edit > General Settings, you can configure how the manager operates. You can set the number of servers that can be assigned to a job and the number of jobs that can be active at a time. The body of the window will report the status of the rendering process and can be minimised if needed.


5.8.2 Server

The server controls the rendering process on an individual machine. When the server is assigned a job from the manager, the server launches a copy of 3ds Max and renders the specified frames. The server must be able to see the network drive where the frames will be rendered.

5.8.3 Server Assigning Jobs

After the manager and server are active, jobs can be assigned to Backburner. This is done via the Render Scene window. When the Net Render box is active, 3ds Max will bring up the Network Job Assignment window when the scene is rendered. The window will first come up with no manager active. Pressing the Connect button will allow you to choose the manager. After this is done, a list of active jobs and servers will appear. You can submit the job to all servers or just selected servers.

5.8.4 Server Monitor

Render jobs can be monitored and managed by using the Backburner monitor program. This Program lists the active jobs and server assignments. It allows you to reassign, reprioritize, and delete jobs. 

6 Rigging

Deformations change the shape of an object. Almost any sort of organic animation from a fully skinned character to flowers swaying in the breeze will need deformations of one sort or another. In addition to using deformations for animation tasks, you can use them as modelling tools. Because deformations can reshape a lot of detail quickly, deformers are good choices for global changes to an object.

Rigging is primarily used in character animation to create hierarchical structures called skeletons. Skeletons are used as a framework for deforming the character as well as animating it. A good rig builds upon the skeleton to provide additional tools that make the animator's job easier by allowing the character to be quickly posed and manipulated.



Rigging Characters

6.1 Bones

Skeletons in 3ds Max can be constructed from any object but are usually constructed from objects called bones, which are tied together in a hierarchy. The skeleton, in turn, is used to deform a mesh via 3ds Max's skinning tools. Although skeletons are used primarily for character animation, they can also be used to create all sorts of other deformations. A garden hose, for example, can easily be deformed by using a series of bones. Bones can also help refine the behaviour of hair and clothing. Bones are used to guide deformations when using skinning tools. When the bones move, the mesh deforms to match. Other objects besides bones (such as boxes or other bits of geometry) can be used in skeletons. When building a skeleton, it is always a good idea to study the anatomy of the character or creature you are rigging. Getting the skeleton anatomically correct will make the resulting deformations anatomically correct as well. The bones of this character closely mimic the bones of a real skeleton.

6.1.1 Creating Bones

To create bones, go to Create > Systems > Bones IK Chain menu or under

the Systems tab of the Create panel. Bones are drawn by left-clicking to set the anchor point, moving the mouse to set the length, and then left-clicking again to set the end point of the bone and the start of the next bone. Right-clicking ends the operation. When multiple bones are drawn, each new bone is created as a child of the preceding bone, forming a hierarchy. Bone chains can be created with or without inverse kinematics (IK) enabled. When IK is enabled, the IK chain is drawn from the first to the last bone in the chain. The Create bones panel Bones can also have fins. These are protrusions on the sides of the bone that can be used to more precisely fit the bone to the mesh.

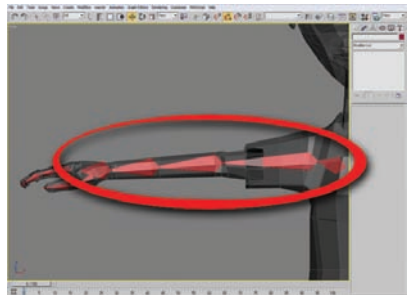
6.1.2 Editing Bones

Bones have a Modify panel where the size of the bone as well as the size and number of fins can be changed. In addition, 3ds Max provides a Bone Tools window (Animation > Bone Tools) to further refine the skeleton. Removing Bones leaves the hierarchy intact, but deleting them breaks the hierarchy. The refine option on the other hand lets you split the bone in two.

6.2 Inverse Kinematics

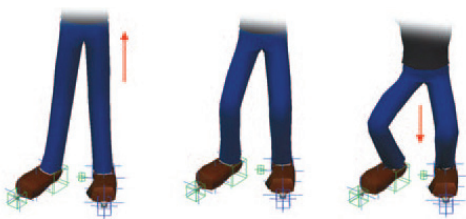
By default, bones in 3ds Max move strictly by rotation. This is called forward kinematics, because a series of bones is manipulated from the root bone forward. If a character picks up a cup of coffee, the bones are posed starting at the shoulder and moving forward to the fingertips. Forward kinematics is great for most motions, but it can pose a serious problem whenever a character needs to keep one part of the body stable while the other moves, such as keeping a foot on the ground during a walk or a run.

To overcome this limitation, inverse kinematics (IK) can be used. Inverse kinematics automatically rotates a chain of bones so that the end points can be positioned by using translation instead of rotation. This is perfect for a character's legs, but also can be used in other areas, such as arms. If a character climbs a ladder, for example, the hands have to remain stable on the rungs while the shoulders move. Inverse kinematics allows you to position the bones simply by translating the IK handle to the desired location, using one step. The



Edit bones to adjust the posture of your character

IK solver rotates the bones automatically. A character's legs are a perfect place to use IK because it allows the hips to move freely while the feet remain firmly planted on the ground.



Positioning characters legs is a perfect place to use IK

6.3 Working with IK

IK can be applied to a bone chain as it is drawn, or it can be applied afterward by applying an IK solver. Choose Animation > IK Solvers, and then the desired solver. Then select the start and the end bone of the IK chain. 3ds Max has three main IK solvers, plus the ability to do Spline IK. The three main solvers are as follows:

- **HI solver**

The History Independent solver uses an IK goal to animate a chain. You animate the goal, and the solver moves the end of the chain to match the position of the goal. This is the preferred solver for most applications.

- **HD solver**

The History Dependent solver lets you use sliding joints combined with inverse kinematics. It has controls for spring back, damping, and precedence not found in the HI solver. The solver, however, is history dependent; performance is slower at the end of long animations.

- **IK Limb solver**

The IK Limb solver is meant for animating the limbs of characters; for example, the hip to the ankle, or the shoulder to the wrist. Each IK Limb solver affects only two bones, but multiple solvers can be applied to different parts of the same chain. IK chains are configured by selecting the IK goal and opening the Motion panel.

6.3.1 Using Spline IK

Another way to configure IK is by using Spline IK, which employs a curve to control the bones and their rotations. This is a good choice for manipulating long chains such as a tail, a trunk, or even a spine. Spline IK works best with chains that have a lot of short bones. To create a Spline IK chain, draw a bone chain with the Spline IK solver enabled. 3ds Max automatically generates a curve of your choice to fit the chain, plus it gives you the option to create helper objects to manipulate the underlying curve and the chain. Once

created, the Spline IK curve is like any other curve and can be animated by using clusters or blend shapes.

6.4 Constraints

Constraints are a way to automatically control an object's position, scale, or orientation. Constraints are used in animation as well as in character rigging to provide animators with ways to attach parts of a character's body to other objects or parts of a scene.

6.4.1 Position

In animation, a Position constraint causes one object to move to and follow the position of another object, or the average position of several objects. Position constraints are particularly useful when you want an object to match another object's position while keeping it outside the hierarchy, such as when a character is lifting something. When the character lifts the ball, the ball is constrained to the palm of the hand. This allows the ball to move with the hand as the hand itself is animated.

6.4.2 LookAt

A LookAt constraint constrains an object's orientation so that the object aims at other objects. In character setup, a typical use of a LookAt constraint is to set up a locator that controls eyeball movement. The eyeball is aim constrained to the locator and rotates to follow it.

6.4.3 Orientation

An Orientation constraint matches one object's rotation to another. This can be used in character animation to set up control objects that affect other objects, such as bones within a rig.

The bone controlled by an Orientation constraint driven by the circle. Rotating the circle swivels the bone.

6.4.4 Link

A Link constraint allows you to animate the links in a hierarchy. Just as with hierarchical linking, a Link constraint matches the relative position, rotation, and scale of one object to another. The Link constraint, however, can be animated to change the link to a different object at a specific frame. This allows for characters to set down and pick up objects. The Link constraint allows the ball to be linked to one hand and then another as the ball passes between them.



With link you can set your character to pick objects

6.4.5 Attachment

An Attachment constraint is similar to a Surface constraint but will work with any polygonal surface. The Attachment constraint works by constraining the pivot point of an object to a specific face on a polygonal object. The constraint shows the face number to be selected along with an offset to fine-tune the position. This constraint works very well for objects that change shape, such as a water surface with waves. The Attachment constraint constrains an object to a specific polygon on a surface.

6.4.6 Surface

A Surface constraint constrains an object to a surface. The types of surfaces that can accept this constraint are limited to surfaces that have UV coordinates, which include parametric surfaces (sphere, cylinder, plane, and so forth) as well as patch, loft, and NURBS objects. The U and V parameters allow the constrained object to be positioned and animated across a surface. The bone is controlled by an Orientation constraint driven by the circle. Rotating the circle swivels the bone. The Attachment constraint constrains an object to a specific polygon on a surface.

6.5 Skinning

Skeletons provide the structure of the body, but the skin provides the appearance. Getting the mesh of the character to deform according to the position of the character's skeleton is called skinning. Most characters animated in 3ds Max will be skinned in some form, and getting a character's mesh to deform smoothly usually takes a good knowledge of the skinning tools and how they work. The Skin modifier is the most popular way to skin a character, but the Skin Wrap and Physique modifiers also can do the job.

6.5.1 Skin Modifier

The Skin modifier works by using a skeleton or a collection of bones to

deform a mesh. Each bone in the skeleton creates an envelope that affects the underlying vertices. Each vertex in the mesh is then weighted to each bone in the skeleton. A bone that completely affects a vertex will be given a weight of 1.0, while bones that do not affect the mesh are given a weight of 0.0. When multiple bones affect a vertex, their weights are somewhere between 1 and 0, but total weights always add up to 1.0. The Skin modifier also has tools to modify the envelopes as well as tools to assign weights manually and to paint weights. User-defined gizmos can be configured to affect the shape of the mesh depending on the position of a bone.

6.5.2 Modifying Weights

Vertex weights in 3ds Max can be modified in a number of ways. Envelopes surround each bone and provide the first level of weighting. Vertices that lie within the envelope are weighted to the corresponding bone. Weights can be configured manually or by painting, by using the tools in the Weight Properties rollout. The Skin Weight tool contains a palette of options to set weights for individual vertices or groups of vertices. Envelopes surround each bone and determine which vertices are affected. Envelopes can be moved and resized. Envelopes can be viewed by selecting the desired bone from the list in the Skin modifier. The Skin Weight table is a spread sheet like table that allows you to type in numeric weights for vertices while the Paint Weights tool allows you to paint vertex weights by using a brush.

6.5.3 Using Gizmos

Gizmos affect the shape of the mesh depending on the position of a bone. 3ds Max has three types of gizmos: Joint Angle, Bulge Angle, and Morph Angle. All of the gizmos are set up the same way. The affected bone and vertices are selected, and then the gizmo is added to the list. The joint is then animated through its range of motions, and the gizmos are modified to reshape the mesh according to the joint's angle. The key frames of the joint's animation are then deleted.

6.5.4 Skin Wrap Modifier

The Skin Wrap modifier is designed to let a low-resolution mesh deform a higher-resolution mesh. This works well for highly complex characters, because the actual mesh that's deformed is independent of the actual control mesh. This means you can modify the high resolution mesh and still keep the animation. The low-resolution object doing the deforming is called a control

object, and the high-resolution object is the base object. A base object can be any type of deformable object.

6.6 Morphing

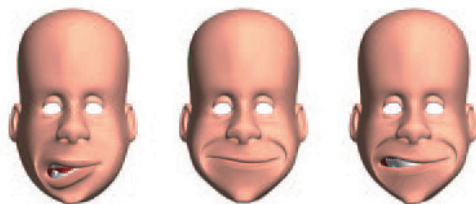
Morphs are managed in 3ds Max by using the Morpher modifier. This allows you to change the shape of one object to match that of another. This is a precise way to deform an object, as each target of the Morpher modifier can be modeled by using 3ds Max's modeling tools. Morphs can also combine multiple targets to mix and match deformations. The big task in configuring morphs is creating the targets. This is primarily a modeling task. The one requirement for blend shape targets is that they all have the same topology as the base object. This is easily accomplished by duplicating the base object (such as a head) and reshaping it to create the appropriate shape (such as a blink or a smile.)

After the targets are created, setting up the morphs is simply a matter of adding the Morpher modifier to the stack and then selecting the targets by using the tools in the modifier. Each target gets a channel, which allows you to set the morph amount for each target. Morphs work by averaging the X, Y, and Z positions of each individual vertex or CV in the object. When a slider is at 0 percent, the vertex is at the rest position; at 100 percent, it is at the target. Mixing multiple targets averages the positions according to the weights on the sliders.

6.6.1 Facial animation using Morphs

Although morphs can be used for any type of shape animation, by far the most popular application for blend shapes is in facial animation. A modeler creates individual facial poses representing the extreme motions of the individual parts of the face, such as opening the jaw or a smile. By mixing these, you can create an infinite variety of facial expressions.

"A" and "I" / "Eh" and "Uh" / "F" and "V" / "L" and "Th" / "M" "Oooh" / "Oh" "E" and consonants, Blend shapes called phonemes can be created



Facial expressions

to mimic the basic mouth positions used in dialogue. Other blend shapes can be modeled for positions the mouth makes when not speaking, such as a smile. It's always a good idea to create right and left versions

of these shapes so that the animator can create asymmetry in the facial expressions. Shapes for the upper part of the face include blinks and brow positions for emotions such as worry, anger, and surprise. Again, it is a good idea to create left and right versions of these shapes to give the animator more control.


6.6.2 Progressive Morphs

Morphs typically work by moving the vertices of the object from one position to another along a straight line. This default motion works great for many applications such as facial animation, but can be problematic when morphing an object that needs to move along an arc, such as the joints of a finger or eyelids moving across the round surface of the eyeball. Progressive morphing addresses this problem by allowing a morph to pass through multiple targets, giving you the ability to create in between shapes.

6.7 Wiring parameters

3ds Max provides tools that allow you to connect the action of one parameter to another. This is called wiring and is useful in character rigging as well as other areas. Wiring allows you to create control panels for characters and areas such as facial animation. It also allows animation along one part of a character to affect others.

Follow the following steps to try it out yourself

1. Right-click on the object and select Wire Parameters.
2. Select the parameter to wire. In the case of a cylinder its radius is selected.
3. Drag the link to the control object and select the parameter used as the control. In this case, the box's Z position is used to control the radius.
4. This brings up the Parameter Wiring window, where the parameters and control direction can be set. In addition, expressions can be added.
5. The wiring is complete. When the box is moved along Z, the radius of the cylinder changes to match.
6. Parameter wiring is used to create control panels, such as this one used to control facial animation.
7. 3ds Max has manipulators, which allow you to create floating sliders in a viewport. These can also be used with parameter wiring to create control panels. 

7 Animation

So far, we've been working in the three dimensions of space. Time adds a fourth dimension to your work. Changing an object over time is called animation, and animation is what truly brings your scene to life. The way an object moves tells the audience a lot about its size and weight and, for characters, its personality. 3ds Max has a wealth of tools for creating and sculpting motion. Learning how to use the tools, though, is only the first step in the process. An animator must understand how the laws of motion work, as well as how the audience perceives motion. Character animators also have to learn how motion affects a character's personality and mood.

7.1 Creating animation

3ds Max offers a variety of methods for creating animation. Each method has its advantages. Understanding each method will let you decide which approach to take when animating a scene. Creating keys is the most common way of animating within 3ds Max. A key simply records a parameter's value at a given point in time. By changing the value over time, you create motion and animation. Keys allow you a wide degree of control over every parameter of an object, from its position to its colour, and just about everything else. To edit keys, you use the Curve Editor and the Dope Sheet. Both allow you to control timing precisely.

Attributes such as position, rotation, and scale can be animated to control how an object moves through space. Any attribute (such as this object's colour) attached to an object can be animated. Parametric animation uses a set of user-defined parameters to create motion. Constraints can match the motion of one object to another, such as this car to the path defined by a curve.

7.2 Using controllers

Controllers are the heart of animation in 3ds Max. Everything that can be animated in 3ds Max is handled by a controller. A controller is a motion plug-in that handles the motion data created through animation. Constraints, as described in the previous chapter, are also driven by controllers. Some controllers can be key framed, others use scripts or mathematical formulas, and others create motion based on user-defined parameters. Much like modifiers used in modelling, controllers can be stacked in a list so that

complex motions and animations can be achieved. Much like with modifiers on the modifier stack, controllers can also be copied and pasted to copy animation. Controllers can also be instanced so that changes in the animation of one object affect another.

Controllers are automatically added to a parameter when it is key framed. These parameters are typically the parameters involved with transformations (position, rotate, scale) but can be any animatable parameter. Controllers can also be added to existing objects to modify the way the objects are animated. Controllers are found under the Animation option of the main toolbar. They can also be assigned and managed in the Curve Editor, the Dope Sheet, and the Motion panel.

7.2.1 Keyframe controllers

The most common type of controller manages the key framing of an object's parameters. These keyframes show up on the time slider as well as in the Curve Editor and Dope Sheet, where they can be edited. The Bezier float controller is the most common of the controllers. It allows motion to be keyframed with the in-betweens defined by a Bezier curve. Linear interpolate the animation linearly, creating a straight line in between keyframes. TCB controllers produce curve-based animation, but do not use Bezier tangents or adjustable tangent handles. These controllers use fields to adjust the Tension, Continuity, and Bias of the animation. The TCB controller creates smoother rotations but does not allow for curve editing.

7.2.2 Parametric controllers

Some controllers use a set of user-defined parameters to create motion. These controllers do not need key frames to operate; after the parameters are set, the animation proceeds on its own.

The Audio controller converts the amplitude of a sound file or real-time sound wave to values that can drive the animation of almost any parameter. This is great for syncing animation to sound. The Noise controller uses random noise to create animation. The strength and frequency of the noise can be adjusted. The spring controller adds spring like dynamic effects to any point or object position, to create secondary motion. This constraint adds realism to generally static animations.

The Waveform controller creates periodic waveforms. This is good for any type of regular animation, such as a blinking light or a pendulum.

7.2.3 Motion Capture Controller

The Motion Capture controller uses input from an external device to control the animation of an object in real time. The controller can use a number of different input devices such as a mouse, keyboard, joystick, or a MIDI controller. After the controller is assigned and the input device is configured, the actual motion is captured by using the Motion Capture utility in the Utilities panel. Expressions use mathematical formulas to control animation. Scripts use MAXScript programming to control animation.

7.2.4 Script and Expression Controllers

3ds Max has controllers that allow you to manage the motion of an object by using either expressions or scripts. Expressions are mathematical equations that connect the motion of one object to another. Scripts are more complex and allow for the inclusion of MAXScript, a programming language native to 3ds Max.

7.3 Creating keys

In 3ds Max, animation is defined by keys, which record parameter changes over time. Almost anything in 3ds Max can be animated, from an object's position in space to its shape and colour. There are two main ways of creating keys: Set Key and Auto Key. When either is active, the viewport is bordered in red to let you know that you are key framing.

7.3.1 Working with the Time Slider

The time slider allows you to move quickly from one frame to the next in order to set key frames or scrub through your animation. The slider is a horizontal bar, divided into frames. Time Configuration lets you define the frame rate, time display, real-time playback, and the length of the animation.

- **Keys**

Each key in the timeline shows up as a box at the keyed frame. Each box is colour-coded: red represents a position key, green is rotation, and blue is scale. Grey keys are for non-transform parameters.

- **Slider**

Left clicking and dragging moves the time slider. Sound is imported into 3ds Max. You can then display it by right-clicking in the time slider and choosing sounds from the menu. Visualizing the sound against your keys helps the animation process.

- **Selecting keys**

Left-click and drag to select multiple keys. You can then left-click and

drag these along the timeline.

- **Graph editor**

Clicking this button brings up a graph editor instead of the time slider.

- **Advance**

Clicking the arrow advance the time by one frame

After keyframes for a particular scene are set, you can play back the animation.

You can play back directly in a viewport simply by clicking the Play button, located toward the bottom right corner of the 3ds Max interface.

- **Last Frame**

Goes to the end of the animation.

- **Back**

Steps back one frame.

- **First Frame**

Goes to the beginning of the animation.

- **Play**

Plays the animation.

- **Key Filters**

Determines the type of keys displayed on the time slider.

- **Key Mode**

Switches the forward and back buttons to move to the next key.

- **Set Key**

When the Set Key button is enabled; pressing the Key icon creates a key.

- **Current Time**

Displays the current time on the time slider. A new position can be typed in.

- **Time Configuration**

Brings up the Time Configuration window.

- **Curve Type**

Determines the type of curve when a key is set.

- **Forward**

Steps forward one frame.

7.3.2 Make Preview

Even on the fastest workstation, complex scenes often do not play back in a viewport in real time. This is when you need to use 3ds Max's Make Preview feature (choose Animation→Make Preview), which steps through the animation and renders a small movie file to disk that actually can be played back in real time.

7.4 Using the Motion Panel

The Motion panel is a place where you can assign controllers, set keyframes, and manage motion. The panel can be considered a close cousin of the modifier stack. Whereas the modifier stack allows you to add modifiers to change the shape or character of an object, the Motion panel allows you to configure and animate controllers that shape the character of the object's motion.

7.4.1 Parameter Mode

Parameter mode displays an object's controllers and allows you to change or modify them. You can also set and manage keys for key framable controllers and adjust parameters for other types of controllers.

7.4.2 Trajectory Mode



The spaceship will follow the specified trajectory

Trajectory mode displays an object's trajectory through a scene. This can be very helpful in visualizing an object's motion. The panel allows you to add and delete keys as well as move, rotate, and scale keys. You can convert a spline path to a trajectory or create a trajectory from an existing spline path.

7.5 Using Track View

Once set, keys can be edited to fine-tune the look and feel of the scene. Simple editing can be done on the timeline by selecting and moving keys or right-clicking them to bring up their controller properties. Keys can also be edited in the Motion panel as well as in the Curve Editor and Dope Sheet. Track View is the interface where you can edit animation for multiple objects as well as assign and edit controllers. The window has two modes: the Curve Editor and the Dope Sheet.

- **Tangent Types**

These buttons change the type of tangent on the selected keys.

- **Curve Tangents**

Tangents can be adjusted by using the Bezier handles.

- **Animation Curves**

Animation curves appear for the selected controllers. These are colour coded. Red curves represent position, green represents rotation, and blue represents scale.

- **Keys**

Keys are represented as small boxes on the animation curves. Selecting a key allows you to move it or change its tangent.

- **Select by Name**

Selects controllers by name.

- **Zoom controller**

Zooms the controller list to the selected controllers.

- **Pan**

Pans the editing window.

- **Zoom Extents**

Zooms to the horizontal or vertical extents of the animation curves.

- **Zoom**

Interactive zoom of the editing window.

- **Zoom Selected**

Zooms to a user-defined area.

- **Track Sets**

Allows you to create named sets of controllers for easy recall.

- **Time Slider**

Scrubs through the scene.

7.5.1 Curve Editor

The Curve Editor displays keyframes as curves. These curves display not only keys, but also the interpolation between keys, giving you complete control over the animation. Each key can be given a tangent type, and if the tangent is a Bezier curve, the shape of the curve can be adjusted.

7.5.2 Working with Curves

Curves define how an object will move. Curve tangents define how the curve is shaped before and after a specific keyframe. By using tangents, you can sculpt the object's motion to create effects such as acceleration and deceleration as well as constant linear motion. Tangents can be applied in either the Curve Editor or the Dope Sheet.

- **Stepped**

Simply jumps from one key to the next. Useful for mechanical attributes

that are either on or off, such as a switched light.

- **Linear**

This tangent offers no change in velocity and is good for objects moving at a constant rate of speed.

- **Smooth**

Creates smooth interpolation through the key without Bezier controls.

- **Custom**

These are the default and use Bezier handles to control the shape of the curve.

- **Flat**

Similar to Bezier curves, but the curves are calculated to eliminate overshoot.

- **Fast**

Causes the animation to speed up around the key.

- **Slow**

Causes the animation to slow down around the key.

7.5.3 Out-of-Range types

When you create keys for an object, you are creating animation over a specific range of time from the first key to the last. For those times that lie outside of the keys, you can use Out of Range types to define how the animation continues outside of the range defined by the keys. This can be used to create cycles of the keys or just hold the last key. These are found in Track View under Controller → Out-Of-Range Types. Holds the value

7.5.4 Dope Sheet

The Dope Sheet presents animation as keys set against a horizontal timeline. This window is used primarily to adjust and set timing because you can see all the keys in a scene at once. You can move, scale, copy, paste, and adjust keys individually, in groups, or hierarchically.

Controllers – Lists controllers available for editing.

Edit Ranges – Creates a mode where you can edit and scale the animation ranges.

Select Tie – Selects a range of keys.

Delete Time – Deletes keys in the selected range.

Reverse Time – Reverses keys in the selected range.

Scale Time – Scales the keys in the selected range.

Object key – Each object has a master key. Editing this key affects all keys for the object.

Transform key – Editing this key affects all transforms for the object.

Keys – Keys appear as coloured boxes. Selected keys are shown in white.

Time selection – When a range of keys is selected, a bar appears under them. Moving this bar moves the keys, or they can be edited by using the Delete, Reverse, and Scale Time tools.

Numeric values – When a key doesn't exist, the numeric values for the parameter appear here.

7.6 Animation Layers

Animation layers (Animation → Animation Layers) let you combine multiple animation tracks on the same object. These layers can be turned on and off as you desire to test out different animations or to keep parts of an animation separate. Layers can be mixed by using the Layer Weight parameter.

Enable Anim Layers – Creates a new animation layer for the selected object

List – Lists the active layers for the object

Layer Weight – Adjusts the amount that the selected layer affects the animation

Add Layer – Creates a new layer

Delete Layer – Deletes the selected layer

Copy Layer – Copies the layer to the clipboard

Collapse Layer – Collapses the active layer to the one below it

Paste Layer – Pastes the layer on the clipboard and creates a new layer

7.7 Parameter Collector

The Parameter Collector lets you create rollouts of animatable parameters so that you can find and key parameter sets with a click or two. One of the Parameter Collector's most powerful features is the ability to change all parameters in a collection. One example is in character animation, where you could animate all the fingers in a character's hand so that they all curl simultaneously.

Rollouts – Parameter sets are stored in user-defined rollouts.

Properties – If a key frame is set for the parameter, this brings up the properties for the key.

Absolute/Relative – Allows multiple edits to be absolute or relative to the given position.

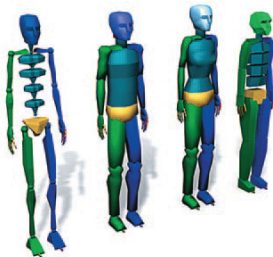
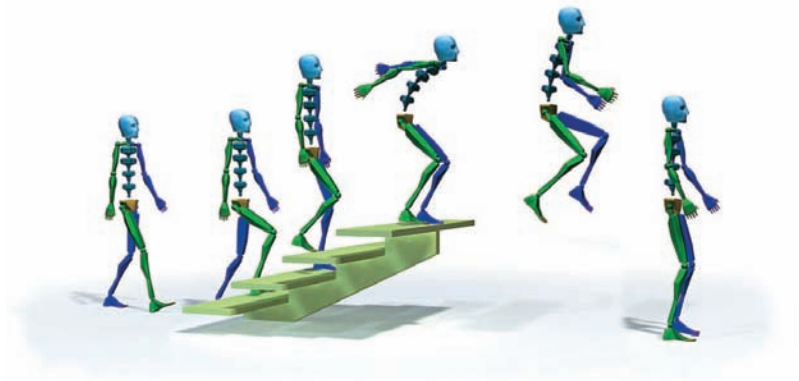
Multiple Edits – When this is enabled, you can edit multiple parameters.

Parameters – Parameters appear in a rollout.

Multi Edit Enable – When these check boxes are selected, changes to one affect all that are selected. 

8 Character Anatomy

Character Studio is a collection of tools that allows for sophisticated animation of characters in 3ds Max. Character Studio used to be an add-on package but is now included with 3ds Max. It has tools to create “smart” skeletons called Bipededs. These skeletons can be animated by using traditional key frame methods, but they also have the ability to accept motion capture data as well as generate their own walks and runs via footstep-based animation. These animations can be refined by using the traditional tools, but they also can be combined by using the Motion Mixer as well as Motion Flow. Character Studio also includes Physique, a character skinning tool, though any of the 3ds Max skinning tools can be used with Bipededs.



8.1 Biped

The heart of Character Studio is the Biped. A Biped is a standardised smart skeleton that has joint limits and other information built-in. The Biped can be created from the Systems tab of the Create panel or by choosing Create > Systems > Biped. Left-click and drag in a front viewport to create the Biped.

A basic Biped is a humanlike skeleton. Biped skeletons come in four flavours: Skeleton, Male, Female, and Classic. The Biped Create panel allows you to customize the skeleton as it is created. The number of joints in the spine, fingers, toes, and many other parts of



A biped can also have a tail or ponytails

the skeleton can be modified. Adding leg links creates a dinosaur like leg structure. Bipededs can have tails as well as ponytails. The number of fingers can be adjusted, as well as the number of toes.

8.2 Modifying a Biped

After the Biped is created, modification and animation takes place in the Motion panel. This panel can be used to create, load, and save motions, and to alter the structure of the Biped. The look of the Motion panel changes depending on the selected mode. Figure mode allows you to refine the structure of the Biped as well as position and scale the Biped's joints. This is the mode used to fit the Biped to a character's mesh. When Figure mode is enabled, the skeleton will snap to the default pose, regardless of any animation applied to the Biped. When the Biped in Figure mode is being fitted to a mesh, joints can be moved, rotated, or scaled. The Figure Mode control panel is very similar to the Create options. The structure of a Biped can be changed here.

8.2.1 The Biped Motion panel

- **Figure Mode**
Allows the Biped structure to be modified
- **Footstep Mode**
Allows footsteps to be created for automatic walks and runs
- **Biped Playback**
Plays the Biped animation in wireframe
- **Motion Flow Mode**
Allows you to use Biped motions as a script
- **Mixer Mode**
Allows you to use Biped motions as motion clips



8.3 Manipulating a Biped

When Figure mode is off, the Biped is ready to be manipulated and animated. A Biped skeleton is a smart skeleton with built-in inverse and forward kinematics. Unlike 3ds Max skeletons, there is no mode that has IK on or off.

Rotating any joint in an arm or leg chain initiates forward kinematics, while moving a hand or foot initiates IK. This makes it much easier to pose the character because you don't need to switch modes.

The Center of Mass (COM) object is a tetrahedral-shaped object located near the pelvis and is used to move the Biped itself. This differs a bit from other types of skeletons, because normally the pelvis would be used for translation. A Biped, however, does not allow for the pelvis to be moved. Instead, it uses the COM object. The COM takes into account the mass of the Biped, so it is not fixed in relation to the skeleton.

Bend Links mode allows related joints of a Biped to be manipulated all at once. For example, selecting a spine joint with Bend Links activated allows rotation of one spine joint to affect all spine joints. The Track Selection rollout gives you tools for manipulating the COM as well as selecting mirror and symmetrical joints on the Biped.

- **Body Horizontal**

Allows you to move and animate the centre of mass horizontally

- **Body Vertical**

Allows you to move and animate the centre of mass vertically

- **Body Rotation**

Allows you to rotate the centre of mass

- **Lock COM**

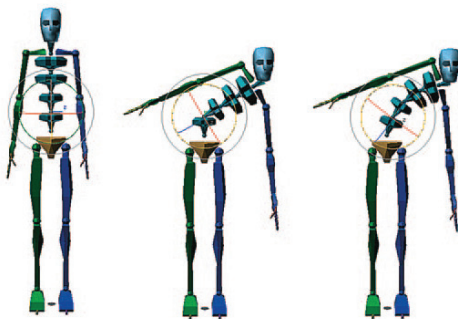
Allows you to turn on Body Horizontal, Vertical, and Rotation all at once

- **Symmetrical**

Selects symmetrical joints, so selecting the right hand will also select the left

- **Mirror**

Selects the same joint (or joints) on the opposite side of the body



Rotating a spine joint without Bend Links (left). When Bend Links is enabled, all the joints rotate evenly (right).

8.3.1 Key framing Tools

The Key framing Tools rollout provides tools to clear and mirror animation on a Biped or selected parts, separate out tracks for key framing, and anchor joints to a point in space. By default, 3ds Max stores keys for an entire limb rather than the individual joints. Generally, this makes animation easier,

because there are fewer tracks. For example, keys for the fingers, hand, forearm, and upper arm are stored in the Clavicle transform track. If you need finer control of the limb, you can use Separate FK Tracks in the Key framing Tools rollout to add additional control.

The Biped Multiple Keys dialog box allows you to set multiple keys for a limb. Select the keys in Track view, adjust the limb, and then click Apply Increment. Normally, adjusting any part of a limb sets a key for the entire limb.

- **Enable Subanim**

Enables Biped subanim. Subanim allows you to place more than one controller on a Biped joint, such as adding a scale controller to stretch a joint.

- **Manipulate Subanim**

Modifies Biped subanim.

- **Mirror**

Mirrors the animation and poses on the Biped.

- **Set Multiple Keys**

Brings up the Set Multiple Keys dialog box, which allows you to apply incremental changes to a limb.

- **Anchor Limbs**

Fixes the selected hand or foot to its current position in space. This allows for positioning of the body while keeping the end of the joint stable.

- **Set Parents Mode**

When separate FK tracks are used, this will set keys for the parents to the affected joints to store the position of the entire limb. This needs to be on when manipulating a joint by using IK and separate FK tracks.

- **Clear Selected Tracks**

Clears all keys and constraints from the selected objects and tracks.

- **Clear All Animation**

Clears all keys and constraints from the Biped.

8.3.2 Key Info

The Key Info rollout allows you to set and modify existing keys as well as view trajectories of Biped joints. Keys can be set for individual joints and limbs as well as for IK. Each type of key has its own rollout that allows you to modify the animation.

8.3.3 Dynamics

Biped dynamics use physics to calculate the Biped trajectory when airborne, the way a knee bends when landing, and how the Biped maintains balance when the spine is rotated. When the Biped is animated, these parameters

adjust the Biped such that it adapts to the new position. These parameters are adjusted in the Key Info rollout, under Body. Balance Factor controls where along the spine the Biped's weight is cantered. Dynamics Blend controls how gravity affects the Biped when airborne. Ballistic Tension controls how the knee bends to absorb a jump or run step.

The Dynamics and Adaptation rollout allows you to use Biped's dynamics engine and set the value of Gravity. Spline Dynamics turns off the dynamics engine and uses spline based animation to calculate keyframes.

8.3.4 Animation Workbench

The Animation Workbench is a custom window for manipulating Biped animation curves. It works in the same way as Track view, and has the same Curve Editor, but it also has additional features for working with Biped curves. These tools include analysis functions to check curves for errors and automatically fix them. This is particularly helpful when working with motion capture data, or any animation that is key frame intensive.

8.4 Footstep Animation

Footsteps enable you to take advantage of Biped's built-in dynamics to create simulated human motion. The basic procedure is to lay down footsteps within the scene and then activate them. After this happens, the Biped will automatically walk from footstep to footstep. The walks, runs, and jumps initially created by using footsteps can be somewhat generic, but subsequent key frame animations can add characters to the original animation. Because footsteps are dynamically driven, key frame animation on certain parts of the character is restricted.

There are two methods of creating footsteps (single or multiple) along with three types of footsteps—walk, run, and jump. The different types of footsteps represent different timings for the footsteps.

- **Footstep mode**

Footstep mode can be entered by using either the Sub-Object pull-down or the Footstep icon.

- **Create Footsteps (Append)**

Allows you to lay down footsteps interactively. This appends the new footsteps after the last footstep in the animation.

- **Create Footsteps (At Current Frame)**

The same as Append, but creates the new footsteps at the current frame. If the new footstep overlaps with an existing footstep, an alert appears.

- **Create Multiple Footsteps**

Allows you to create multiple footsteps using user specified spacing and timing.

- **Walk**

Creates new footsteps using walk timing.

- **Run**

Creates new footsteps using run timing.

- **Jump**

Creates new footsteps using jump timing.

When Walk footsteps are selected, it determines the length of a footstep in frames. This spinner changes depending on whether Walk, Run, or Jump is selected. The amount of time both feet are planted in a walk, spinner changes depending on whether Walk, Run, or Jump Both feet are on the ground equally or airborne equally. Footsteps can be created one at a time, which can be necessary when a character is walking on an uneven surface, such as these steps. When the character is walking across a regular surface, Create Multiple Footsteps can be used. The Create Multiple Footsteps window allows you to define the number of footsteps as well as the lengths and widths of the footsteps. For a run One foot is on the ground at a time with no double support. There is also a point in the animation where both feet are airborne.

8.4.1 Activating Footsteps

After footsteps are created, they must be activated. Activation computes the dynamics for the Biped for any footsteps that have been created but not activated. It also creates keys that can be viewed in Track view or the timeline. After footsteps are activated, you can still edit and modify their placement and timing. Footsteps are activated in the Footstep Operations rollout.

8.4.2 Editing Footsteps

Once activated, footsteps can be edited to change the motion of the Biped. Footsteps can be selected, and then translated or rotated. The Footstep Operations rollout has tools to bend selected footsteps (that is, curve the path of the footsteps) or scale selected footsteps (that is, lengthen or shorten the stride). The timing of the footsteps can be edited in the Dope Sheet.

8.4.3 Using Motion Capture

Motion capture allows you to apply recorded body motion to a Biped. Motion capture systems use markers to record the positions of various body parts over time. This marker data can be applied to a Biped's joints to create motion.

Typically, motion capture files record keys at every frame. Biped lets you filter the data as it is applied to the Biped as well as extract footsteps for footstep animation. Motion capture is managed by using the Motion Capture rollout.

Motion capture is imported by using the Load Motion Capture File option in the Motion Capture rollout. 3ds Max supports Biovision (.bvh) and Character Studio (.csm) marker files. When a file is selected, the Motion Capture Conversion Parameters window applies the marker data to parameters that you set. The Motion Capture rollout allows you to load motion capture files and fit the Biped to the talent used for motion capture.

Setting used to After motion capture data is imported into 3ds Max, it can be edited by using the Animation Workbench. Edited motion capture can then be saved in 3ds Max's Biped (.bip) format. A motion that has been converted to Biped format can then be applied to any Biped, regardless of its size and scale.

8.4.4 Motion Flow Mode

Motion Flow uses BIP files as clips in a script. The motion-flow script joins clips together by using transitions. Transitions can be unconditional, chosen at random, or governed by rules such as collision detection. You can control when a transition begins and ends. You can use Motion Flow to animate a single Biped or a crowd of Biped.

The Motion Flow rollout allows creating and saving motion scripts. The Motion Flow Graph window is where biped motions can be connected together to create transitions.

8.5 Motion Mixer

The Motion Mixer allows you to combine motion clips for both Biped and non-biped objects. It works very similarly to a nonlinear video editor. Motion is contained in clips, which can contain entire Biped motions or the motions for a single object. Clips are loaded into tracks, which allow you to adjust timing as well as mix transitions from clip to clip. The Motion Mixer lets you to work with animation above the level of the key frame. Motion Mixer is used mostly with motion capture files to mix and combine the various takes to create an entire motion. Traditional key frame animation can also be stored as clips for more-stylized motion. Clips are stored as individual files and are loaded into tracks.

- **Track**

A track can hold multiple clips. Top tracks are processed first.

- **Active track**

The active track is highlighted.

- **Transition track**

When animation needs to be transitioned between two clips, a transition track is used.

- **Mute**

Turns off the track.

- **Add Max Objects**

Adds objects to the mixer.

- **Add Biped**

Adds Biped objects to the mixer.

- **Start frame**

The start frame shows at which frame the clip starts.

- **Weight curve**

When weights are animated, a curve shows over the clip. This curve shows how the clip fades in or out.

- **End frame**

Shows the last frame of the clip.

- **Transition**

When two clips in a transition track overlap, a transition appears between them. The edges of the transition can be dragged to adjust its length.

- **Weighting**

Animating this parameter adjusts the weight of the clip, allowing clips to be mixed between tracks.

- **Solo**

Turns off all tracks except the solo track.

A clip is simply a collection of animation curves. Clips let you gather an object or Biped's key frame or motion capture data into a single place so you can manipulate the character all at once. Clips are stored on the disk as motion files. They can be Biped (.bip) or Max animation (.xaf) files. Clips are loaded into the Motion Mixer into the selected track or they can also be loaded and stored in the Reservoir. The Reservoir allows you to load clips and manage them. Clips can be trimmed by selecting an edge of the clip and dragging it. Transitions have an optimization feature that can automatically find the best timing for a transition between two clips. This is preferable for foot-based animation because you can tell the Motion Mixer to focus on a specific foot. Weighting allows a clip to affect the animation more or less at different times. Weight curves can be adjusted by turning on weighting

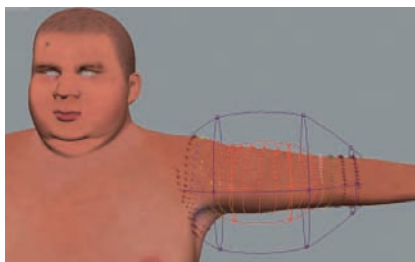
in the track, and then clicking and dragging the weight curve. Time Warps allow the animation in a clip to be squashed and stretched over time, allowing a motion to be retimed.

8.6 Physique

Physique, similar to the Skin modifier, attaches mesh to a skeleton such as a Biped. When you animate the skeleton with skin attached, Physique deforms the skin to match the skeleton's movement. Physique works on many objects, including geometric primitives, editable meshes, patch-based objects, NURBS, and even FFD space warps. Physique has several advanced features, such as the ability to create bulges, skin sliding, the amount of twist, and crease blending as a character moves. Physique's envelopes are much more customizable than skin, but it does not have Skin's sophisticated vertex weighting or painting and cannot do morph-based deformations.

8.6.1 Applying Physique

Before Physique is applied, the Biped needs to be in Figure mode. As with most characters, it's best to use a pose with the arms outstretched so the hands are away from the torso. This makes initial envelope assignment



Physique makes the skin deform with bone movement

easier. Apply the Physique modifier to the mesh. The main level of the Physique modifier has a tool called Attach To Node, which attaches the modifier to the root node of the hierarchy. In the case of a Biped, the root node is the Pelvis, not the COM. The COM actually moves as the Biped maintains balance, so that can cause unwanted bulging if it were included in Physique. Once

attached, Physique walks the hierarchy and adds all the attached joints. This works differently than Skin because Skin accepts any object as a bone, regardless of hierarchy. To add bones or joints outside of the hierarchy, use Physique's Floating Bones rollout.

After Physique has been initialized, adjustment of vertex weights and envelopes can begin. The process is usually done by adjusting vertices and envelopes first, and then moving on to bulges and tendons. The best way to test how the skin reacts is by animating the joints of the character so you

can adjust Physique parameters and then scrub the timeline to instantly see the results.

8.6.2 Applying Physique Vertices

The Vertices sub-object determines how each vertex of the mesh will be assigned and how it will deform. Vertices can be assigned to one of three categories: Deformable, Rigid, or Root. Deformable vertices accept deformation from attached nodes and will flex and bend. Rigid vertices move with the attached joint but do not deform. Root vertices do not move with the skeleton.

Deformable – Deformable vertices are indicated in red.

Rigid – Rigid vertices are indicated in green.

Fixed – Fixed vertices are indicated in blue.

Blending Between Links – Determines how the joints affect the vertices. The default is N Links, which allows any link to affect a vertex. This can be changed to limit the how many joints affect a vertex.

Select - Selects vertices for modification.

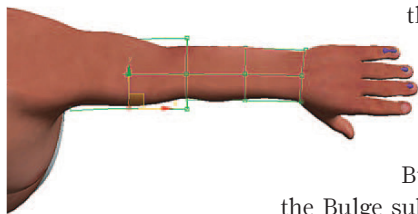
Red vertices deform, such as the vertices in the arm. Green vertices move with the joint but remain rigid, such as the head and Blue vertices do not move with the mesh. Looking for blue vertices is a good way to chase down unassigned vertices.

8.6.3 Envelopes

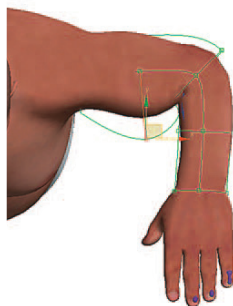
Envelopes are the Physique modifier's primary tool for controlling skin deformation. They are accessed by using the Envelopes sub-object. Envelopes work very similarly to the envelopes found in the Skin modifier. Each joint produces a pill-shaped envelope that surrounds the mesh and includes those vertices close to the joint. The size and shape of the envelope can be adjusted. Envelopes can also be set as deformable or rigid. When envelopes overlap, the weighting is balanced between the envelopes. Envelopes have three types of controls: Link, Cross Section, and Control Point. Link is the entire envelope, Cross Section is the radial cross section of the envelope, and Control Points are the points that control the shape of the cross section. Envelopes surround a joint and include the vertices close to the joint.

8.6.4 Bulges, Creases, and Other Deformations

In addition to envelopes, Physique has several other methods to deform the mesh based on the movement of the skeleton. Bulges allow the skin to bulge as the joints move. Tendons link one joint to another and spread



the effect of moving a joint to the skin around adjacent joints. Link Settings determine how the skin between joints behaves, such as the crease of an elbow.



Bulges can be accessed by using the Bulge sub-object, but there is also a floating Bulge Editor window that provides a graphical interface. Bulging is configured by animating the joint and setting bulge angles for each point. For the bulging of a bicep, for example, the elbow would be animated straight and at 90 degrees to create two bulge angles. Then using the Bulge Editor or the interactive tools in the viewport, the cross sections and control points are reshaped to create the desired bulge at each angle.

Control Point tools – Tools to draw, create, and delete control points.

Select and Translate – Tools to select, move, rotate, and scale control points.

Bulge profile – The profile of the bulge is displayed graphically.

Cross Section tools – Tools to create, delete, and adjust cross sections.

Bulge Angle tools – These buttons set, insert, and delete bulge angles from the pull-down list.

Bulge angle – The selected bulge angle. The bulge angle can be changed by pulling down the list.

Bulge angle parameters – Influence, Power, and Weight parameters, exactly the same as in the Bulge sub-object rollout.

Cross Section/Bulge Angle – Switches between Cross Section and Bulge Angle mode. **d**

9 Special Effects

3ds Max is used as a special effects tool in the film, video, and game industries. Special effects can be created in various ways, but many of the best special effects simulate reality. 3ds Max has tools for creating and animating objects that respond to real-world forces such as gravity. Objects animated in this way can appear highly realistic and can seamlessly blend with real-world scenes.

Particles simulate the motion of large numbers of objects and are terrific for all sorts of fire, water, and atmospheric effects. 3ds Max has several basic types of particle systems, as well as Particle Flow, which offers much more sophisticated tools. Reactor's dynamics allow objects to animate and collide with each other by using forces, and soft body dynamics allow physical forces to affect the actual shape of an object.

9.1 Particle Systems

Particle systems are used to simulate all sorts of natural phenomena, from smoke and fire to rain, sparks, and any other effect that requires animating a large number of objects. In 3ds Max, there are several types of particle systems. Basic particle systems allow for simple simulations such as a spray or cloud of particles. These basic systems can be affected by forces so they can interact with an environment. For more-sophisticated applications, Particle Flow is an event-driven system that allows for a high degree of control over particle behaviour.

9.1.1 Basic Particle Systems

3ds Max has several types of basic particle systems, also called non-event particle systems.

These provide straightforward tools for creating simple effects such as snow, rain, exhaust, water sprays, and more. These particle systems are located in the Create tab.

The Spray particle system emits particles from a simple plane in a spray like pattern. Super Spray is a much more robust version of Spray and allows for control of spray direction. Snow simulates falling snow or confetti like particles that fall from a plane in a random pattern. Blizzard is a more robust version of snow and can create more types of particles, including meta particles and instanced geometry. Particle Array uses geometry as the

emitter, allowing any object to emit particles. Particle Cloud creates particles within a user-defined volume. This is good for clouds or other types of effects that need to be confined to a specific area.

9.1.2 Particle Types

Each particle system is slightly different, but they can create many of the same types of particles. These can be standard particles, instanced geometry, or blobby meta particles. The Particle Type rollout, available in Super Spray, Blizzard, PArray, and PCloud, contains all the basic particle types.

- Triangle creates flat triangular shaped particles.

- Special creates particle shapes consisting of three intersecting planes.

- Constant creates circular shaped particles.

- Six Point creates particles shaped like six pointed stars.

- Cube creates cube-shaped particles. Facing creates planar particles that always face the camera.

- Tetra creates tetrahedral-shaped particles.

- Sphere creates spherical particles.

- Meta particles are blobby particles that create fluid like effects.

- Instanced Geometry allows you to use any 3ds Max object as a particle.

9.1.3 Particle Generation

In addition to the type of particle, the particle system needs to know how the particles will be generated. This information includes the number of particles, their speed, and the length of time that the particles will live. Use Rate creates a specific number of particles per frame. Use Total creates a fixed number of particles over the life of the system. Particle Motion determines the speed of the particles with a Variation control to randomise the speed. The size of the particles, along with a Variation spinner adds to the randomness. The number of frames it takes to grow the particle to full size and the number of frames to fade it out from full size is decided under the Particle Timing menu. A random number needs to be used to initialise the system. You can directly set the frames where the particles start and stop emitting, and the frame where the particles disappear, regardless of other settings can also be set in the Particle Generation Panel.

9.1.4 Particle Motion

In addition to speed, particles can rotate and collide with each other as well as spawn new particles when they collide with other objects. This adds

another layer of realism to the system. Rotation And Collision defines how particles spin as well as how they behave when they collide with each other. Bubble Motion simulates the wobble effect that happens in bubbles rising underwater.

Typically, it's used when the particles are set to rise in thin streams. Object Motion Inheritance determines how particles will be affected by the movement of the emitter. Particle Spawn allows new particles to be created when they collide or die.



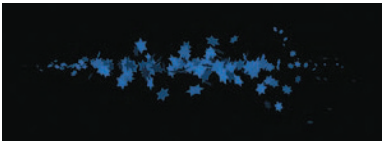
Triangle



Cubes



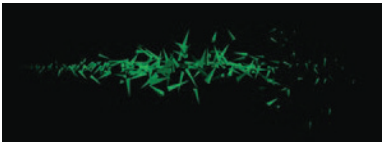
Constant



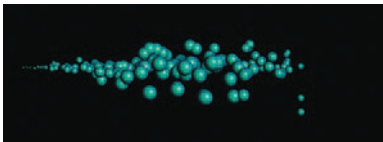
SizPoint



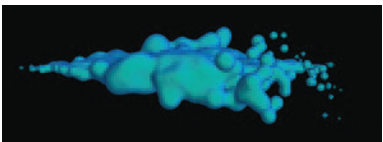
Cube



Tetra



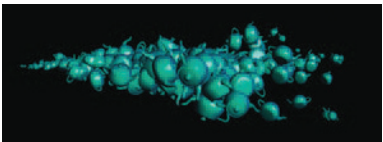
Sphere



Metaparticles

9.1.5 Texturing Particles

Particles can be textured by using the standard 3ds Max materials. This is good for pure colour, but when particles need to have texture applied,



Instanced Geometry

face mapping must be used. This can be set in the Material Editor. Many types of effects require that the particles change colour over the course of their lifetimes. A red fire particle, for example, might change into a grey particle as it ages to simulate fire turning into smoke. Some effects can require a particle's opacity to change as it gets older. This can be done by using the Particle Age mapping type.

9.1.6 Forces

The motion of particles can be affected by forces. Forces can create such effects as gravity, wind, and vortex. Forces are found in the Create panel, under Space Warps. To connect a particle system to a force, select the particle system, press the Bind to Space Warp icon, and drag the line to the force icon.

Wind is similar to gravity but can have turbulence.

Vortex creates a radial vortex. Vortex is useful for creating black holes, whirlpools, tornadoes, and other funnel like objects.

Motor applies a rotational force to a particle system.

Path Follow allows particles to follow a spline path, in this case, a star.

Gravity pulls particles in a specific direction, usually toward the ground.

9.1.7 Deflectors

Deflectors allow particles to collide with objects. Deflectors are found on the Space Warps tab of the Create panel. Deflectors can take the shape of planes or spheres and can also use 3ds Max geometry as the deflector objects.

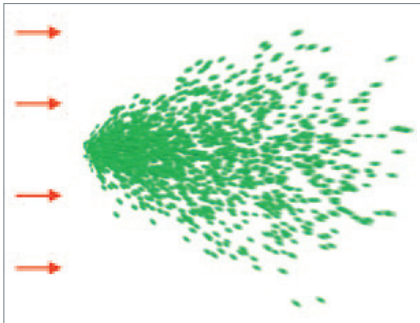
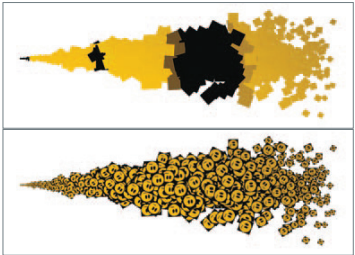
The standard deflectors are Deflector, which is a planar shaped deflector, SDeflector, which is spherical, and UDeflector, which uses geometry. OmniFlect deflectors come in three types: POmniFlect is planar shaped, SOmniFlect is spherical, and UOmni Flect uses geometry. OmniFlect deflectors have additional parameters for chaos, reflection, and refraction. DynaFlect deflectors allow the force of a particle system to affect actual objects in a 3ds Max scene. This allows a fire hose to knock over an object, for example. Deflectors allow particles to collide and to be deflected by objects.

9.2 Particle Flow

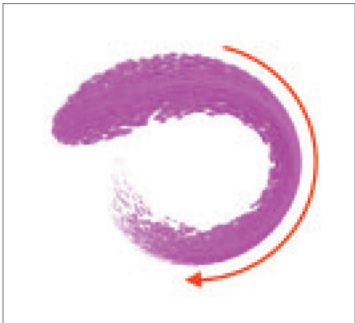
Particle Flow is an event-driven particle system. Creation of a Particle Flow system starts with creating a PF Source particle system. Once created, Particle Flow systems can be built and modified in the Particle View window. Within this window, you can add events and operators to the system that can

affect almost any aspect of the particles. Particle Flow starts by creating a PF Source particle system.

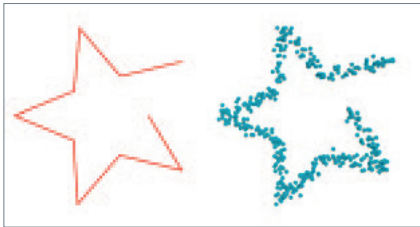
- **Event Display**–This window contains all the events.
- **Help**–Highlighting an object in the depot displays help about its purpose here.
- **Parameters**–Shows the parameters for the highlighted part of the event window.
- **Global Event**–This is the first event in the system and has the same name as



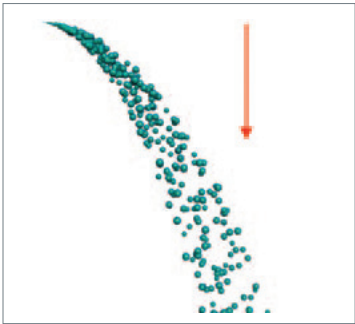
Wind Force on the particles



Vortex Forces on particles



Path Follow forces on particles



Gravity always pulls the particles down towards the ground

the PF Source icon in the scene.

- **Link**–Links connect two events together.
- **Events**–These affect the behaviour of the particle system.
- **Depot**–The depot contains operators that can be dragged into the

9.3 Reactor

Reactor animates objects automatically to simulate the effect of real-world forces and collisions. Reactor can create rigid bodies, which do not deform as they collide, or soft bodies, which change shape as they collide and move. Reactor creates highly realistic looking animation and is good for simulating natural motion. Reactor has its own menu on the main menu bar, which contains all of reactor's objects and modifiers, as well as tools to define object properties and to create and preview animations. Reactor objects can also be found in the Create panel, under Helpers. The Utilities panel also has a Reactor button that allows you to configure the dynamics engine and create animations.

9.3.1 Rigid Body Dynamics

Reactor can create rigid body dynamics to simulate how physical objects move in the real world. These tools can be used to simulate objects falling, colliding, or being affected by physical forces such as wind and gravity. The solutions can be physically accurate, making the result very realistic.

9.3.2 Creating a Simulation

Rigid body simulations are set up by creating a rigid body collection containing each object in the simulation, defining each object's physical properties, adding in forces, and then running the simulation.

Create a rigid body collection (reactor→Create Object→Rigid Body Collection). There is a list containing all the objects in the simulation. Objects can be picked individually from a viewport or added from the list. Each object has a set of object properties that define physical properties about the object such as mass, friction, and elasticity. These are accessed via reactor→Open Property Editor. Objects that remain passive, such as the walls and the floor, are given a mass of zero, while active objects, such as the ball and boxes, are given masses larger than zero. After the properties are set up, the animation can be created. The reactor tab of the Utilities panel contains tools to create and preview the animation. The tab also contains a rollout for configuring the parameters of the world, such as the force of gravity. Animation previews appear in the Real-Time Preview window. When the preview is approved, the final animation can be generated. This creates keyframes for all the objects in the scene.

9.3.3 Forces

In addition to reactor's built-in gravity, other forces can be used to create

more realistic animations. Wind creates a directional force, with additional controls for turbulence. Motor acts to turn rigid objects, such as the blades of a helicopter.

9.3.4 Constraints

Constraints let you restrict how objects move in the simulation. They can fix objects to each other or let them move only in specific ways. The Point-Point (point-to-point) constraint lets you attach two objects together. The objects can rotate in relation to each other, but always have the attachment point in common. The Point-Path constraint allows you to constrain two bodies so that the child can move along a path relative to the parent, much like a bead on a wire. The Prismatic constraint allows its bodies to move relative to each other along one axis only. The Ragdoll constraint lets you realistically simulate the behaviour of body joints, such as hips, shoulders, and ankles. This is very useful for creating digital stuntmen. You can use the Carwheel constraint to attach a wheel to another object—for instance, a car chassis. You can also constrain a wheel to a position in world space. During the simulation, the wheel object is free to rotate around a spin axis defined in each object's space. The spring constraint lets you create a spring like effect between two rigid bodies in the simulation, or between a rigid body and a point in space. The Hinge constraint allows you to simulate a hinge like action between two bodies.

9.3.5 Helpers

Helpers let you define specific types of simulations, such as an automobile or a fracturing object. Fracture simulates the breaking of a rigid body into pieces as the result of an impact. To do this, you need to create the pieces that are glued together to create the whole object. Toy Car simulates a simple car without having to set up each constraint separately. This option lets you choose a chassis and wheels for your car, tweak various properties such as the strength of its suspension, and specify whether you would like reactor to turn its wheels during the simulation. Soft bodies can be used to make this character's belly jiggle.


9.3.6 Helpers Soft Bodies

Soft bodies are objects that change shape when affected by forces and motion. They are great for secondary motion such as a waving flag, a jiggling belly, or a dog's floppy ears. Soft bodies are similar to cloth, the main difference

between them being that soft bodies have a sense of shape. A soft body will tend to return to its original shape after motion settles. Soft bodies are created by using a soft body collection and a soft body modifier. The modifier is applied to a mesh to add soft body properties, and these are then collected for simulation. Soft body simulation is done by using the same tools as for rigid body simulations, and soft bodies can interact with rigid bodies.

The soft body collection (reactor > Create Object > Soft Body Collection) incorporates all of the objects with soft body modifiers into the simulation. Soft bodies can also be used to deform FFDs, which in turn deform meshes. This can help speed processing with complex meshes. The soft body modifier (reactor > Apply Modifier > Soft Body Modifier) allows an object to behave as a soft body.

9.3.7 Cloth

Cloth in reactor creates simple cloth objects, such as curtains, flags, or capes. More complex garments can be created by using 3ds Max's cloth system. Cloth works much in the same way as soft bodies, but unlike soft bodies, cloth does not retain the original shape of the object. Cloth is created by using a cloth collection and a cloth modifier. The modifier is applied to a mesh to add soft body properties, and these are then collected for simulation. Soft body simulation is done by using the same tools as for rigid body simulations, and soft bodies can interact with rigid bodies. Cloth can interact with rigid body simulations. 



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